Report No. 1

TREE HUSBANDRY PRACTICES IN TAMILNADU

Prosopis juliflora
Casuarina equisetifolia

S. KONDAS

SOCIETY FOR SOCIAL FORESTRY RESEARCH AND DEVELOPMENT TAMILNADU

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Casuarina equisetifolia

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1992

Society for Social Forestry Research & Development Tamil Nadu

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The Society for Social Forestry Research and Development, Tamil Nadu (SSFRDT), encourages applied research projects in social forestry. The society is a body consisting of representatives from government, non-governmental organizations and scientists. The objectives of the Society is to encourage extra-departmental research with an inter-disciplinary approach and transfer the tested knowledge in the lab to the land by conducting field trials. Effective dissemination of new knowledge to the practitioners of social forestry is one of the important aims of the Society. The society closely interacts with Forest Department, Agriculture Department and Rural Development Department in order to understand their needs and transfer the results of the various research project to fulfil their needs. It supports universities, research institutions, non-governmental organizations and individual scientists in conducting applied research. The managerial decisions in the Society are made through a Committee. The Research and Development Cell of ISO/Swedforest assists the Society in all aspects of project identification, management and dissemination ofr results.

Mr. S. Kondas, I.F.S. (Retd. Principal Chief Conservator of Forests) is one of the leading foresters in India. Before his retirement he has had a rich and varied career with a strong bias for research. His experience ranges from able administration to independent scientific pursuit.

Mr. S. Kondas has presented several original field studies at national and international conferences. He has had the opportunity to investigate field problems concerning tropical pine culture, productivity of *Eucalyptus tereticornis*, biology of bamboos and silviculture of *Casuarina equisetifolia*. The present study is yet another example of his broad perspective he has developed over the years.

Cover photo : Private *Casuarina* plantation near Andikuzhi, South Arcot district.
PHOTOGRAPHS BY MR. S. KONDAS.

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PREFACE

PROSOPIS JULIFLORA as found in the districts of Kamarajar, Nellai-Kattabomman, Chidambaranar, Ramanathapuram and Pasumpon Thevar Thirumagan and *Casuarina equisetifolia* in Chengalpattu-MGR and South Arcot formed the theme of this study. The object was to take a quick look at the species regarding distribution, biology, cultivation, impact on agriculture, marketing, the people and social interactions and compile useful information on tree culture, consequent development of natural resources and employment potentials and promotion of socio-economic growth.

The two species are very different from each other. *Prosopis juliflora* was once, considered worthless and a nuisance but has now become a valuable social asset on its own in less than two decades. It has proved to be a provider of employment to landless rural poor for whom agriculture is uncertain. *Casuarina* fits the cropping patterns admirably, is a worthwhile cash crop to the discriminating farmer and a good addition to source of non-conventional energy under regular husbandry practices.

Two questionnaires were framed for the purpose of field work. Dr. S.M.A. Aslam and Mr. V. Sivaraman, retired forest officials, did a splendid job of collecting first hand information which was very useful. I spent 28 days on field study and the visits to the seven districts gave me an opportunity to study the different situations and the people. This also helped me to clarify many points and issues in the preparation of this report.

Estimation of *Casuarina* growth is still a bit of a gamble. Prof. J. Vijayathilakan, Professor and Department Head, Madras Christian College, Tambaram, Madras lent the services of his professors and students. Prof.R.Chandrasekaran took up mensuration study of *Casuarina* and prepared Volume and Weight Tables for use as ready reckoners. Perhaps these tables are the first of this kind for private *Casuarina*. I am thankful to my forest department colleagues and professors of the Madras Christian College for their sustained interest and support.

The project was fully funded by the Society for Social Forestry Research and Development, Tamil Nadu. I am specially grateful to Dr. M. S. Swaminathan, Chairman of the Society for his appreciation of the objectives of the proposal and approval of the project. The staff of the society, particularly Dr. K. Balasubramanian, Research and Development Manager, was highly co-operative in this endeavour.

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S. KONDAS

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HIGHLIGHTS AND COMMENTS

PROSOPIS JULIFLORA

1. *PROSOPIS*, A SOCIAL ASSET

In the five districts (24,04,500 ha) cultivable waste and other fallow lands occupy 4,80,900 ha (1989-90) and dry land agriculture 5,94,300 ha totalling 10,75,200 ha. Based on an estimated production of wood and charcoal the probable area of *Prosopis* under active exploitation may vary from 3 to 4.5 lakhs ha depending on the average productivity of anything between 10 and 15 tonnes / ha. It is likely that natural *Prosopis* of such an extent would be found in the categories of the lands mentioned above. Its socio- economic importance becomes very obvious if past attempts to raise community plantations under the Social Forestry Programme are recalled. Nearly four lakhs ha were raised since 1960-61 in the entire State, the outlay exceeding Rs.120 crores. *Prosopis* has proved to be a great social asset at no cost to the government. It has brought back vast stretches of land into use and labour into productive employment. (6.34 million man-days and 7.03 million woman-days per annum).

(Para1.01, 3.01 to 3.04, 8.01)

2. *PROSOPIS,* THE GREAT PROVIDER

Prosopis ecologically successful and favoured by many contributory factors, has overrun available lands in the five southern districts in the last two decades and now occupies 3,00,000 to 4,50,000 ha, which is under exploitation. No doubt it is a vigorously regenerating, plentiful and useful crop where agriculture is uncertain and life frustrating. It is a great natural boon, because man has no hand in its development except exploitation. The total annual wages by way of exploitation amounts to Rs.232 millions working out to Rs. 2,323 per ha once in three years or a notional annual wage accrual of Rs.774 per ha. The other benefits include hire to owners of double bullock-carts and lorries, wages to sundry workers, brokerage, business to firewood merchants, sustenance to village artisans (carpenters and blacksmiths) and feed to livestock· (Para 2.01 to 2.03, 8.01, 11.01)

3. *PROSOPIS* AND GROUND WATER

Nevertheless *Prosopis* could become a bane in the sense that farmers have to spend a lot of energy and effort to keep it off their cultivating lands and there is little respite from this highly invasive species. The fears of many villagers, we talked to, that it lowered the water table do not appear to be wholly unfounded.

We have no knowledge of dry land ecology, much less the effect *Prosopis* has on ground water. The ground water *vis-a-vis Prosopis* is an important topical theme in the context of overall groundwater depletion and needs immediate study.

4. *PROSOPIS* SILVICULTURE

Prosopis productivity and its response to repeated fellings on short cycle is far better than native species considering the agroclimatic conditions. It is high time that silvicultural system for maximum volume production is taken up for a detailed study. It is worthwhile to study the economics of fertilization. The logistics for aerial fertilizer application are favourable where large blocks running to many hundreds of hectares occur in Ramanathapuram, Pasumpon Thevar Thirumagan and Kamarajar districts, particularly at their boundaries. The study should take into account groundwater considerations. (Para 4.01 to 4.05)

5. RETHINKING OF SOCIAL FORESTRY ACTIVITIES

Under the Social Forestry Programme Phase I and II *Babul* is the choice of species for tankbed planting in these districts as per general plan. Ecologically and socio-economically *Prosopis* has proved itself a much better species than *Babul*. In fact in one tank bed in Ramanathapuram district, a group of women labourers toiling on removal of *Prosopis* for *Babul* planting by the Forest Department were vociferously protesting against the replacing of *Prosopis* by *Babul*. It was a genuine and a meaningful protest. Economically a hectare of *Babul* planting generates 44 man-days and 123 woman-days employment and exploitation 80 man-days and 40 woman-days provided the yield of wood is 20 tonnes per hectare; often it is less than that. The coupe contractors use their own trained labour for exploitation, denying the local people the benefit of wages. The total wages amount to Rs.2,090 once in ten years (i.e.) Rs.209 a year as against Rs.774 a year from *Prosopis* (exploitation and charcoal making only.) *Babul* is not favoured for another reason and according to local people the charcoal out-turn is 150-180 kg / tonne of wood which is less than that of *Prosopis* and it is more brittle. The Programme with emphasis on *Babul*, if continued, will only amount to denying the poor an additional earning of Rs. 565 for every hectare of planting. It is evident that even Phase II of the Social Forestry Programme does not seem to reflect the realities of the situation. Such blanket plans prepared at State level with no grassroot level contact lack the sensitivity of social underpinning and are not likely to achieve the objective.

(Para 8.01)

6. CHARCOAL MAKING

Moisture content of wood at the time of carbonisation is an important factor for getting high quality and quantity of charcoal. Otherwise part of the wood charged into the kiln is used for driving away the moisture which could be avoided by sun-drying. But this is not followed and the felled wood goes straightaway for the process. Second, stacking the wood is time consuming and costly. Third, forced cooling by dousing with water rather than allowing it to cool naturally reduces output and adds to the cost of process. The workers are against radical changes in the process nor are the charcoal producers willing for higher investment, say in portable steel kilns.

A detailed study to suggest changes in the technique and process is very essential for maximising output and wage earning. (Para 7.04 to 7.09)

7. MONEY-LENDING

The usurious rate of interest (60 to 120 per cent) in the rural areas reduces the entire activity to one of poverty alleviation measures and keeps the socially handicapped rural poor (Scheduled Castes) in a perpetual state of abject poverty. The rural banks are of no help. Here is a rare instance of a natural resources being available for productive employment but lack of contributory factor like credit on easy terms simply does not make it happen. (Para 9.01)

In sum *Prosopis*, no doubt, is the staff of life for a multitude of rural poor. How to handle it, environment friendly, and at the same time how to maximise the flow of benefits to the deserving rural poor merits a comprehensive and high priority study.

HIGHLIGHTS AND COMMENTS

CASUARINA EQUISETIFOLIA

1. *CASUARINA,* FARMERS' FAVOURITE

Casuarina is today a farmer's favourite fitting admirably into the cropping patterns cash crops (ground-nut, sugarcane, tapioca, paddy, vegetables etc). If it maintains its forays into agriculture it could cause a dent on food production in the districts of Chengalpattu-MGR and South Arcot. Since agriculture heavily depends on groundwater (60 per cent) judicious use of water and balanced economic growth assume great importance and merits a serious study.

(Para 1.01 to 1.09)

2. TREE CULTURE OF *CASUARINA*

i) Population Density

Studies on other species have shown that greater volume production results from closer spacing; at the same time closer spacing may result in early competition and higher rates of mortality. It is obvious that what most of the *Casuarina* farmers are doing is counterproductive. Optimum population densities for irrigated and unirrigated areas needs to be taken up for study. Mortality means not only death of plants but also avoidable depletion of groundwater.

(Para 2.09 and 2.10)

ii) Weeding and Pruning

While weeding gives a good start to the seedling, pruning promotes better tree formation and good biomass distribution in the trees. Schedules of weeding and pruning for typical situation need to be worked out. (Para 2.12)

iii) Fertilizer Application.

The present fertilizer practices have not been scientifically tested. Inspite of rising prices it is necessary to conduct fertilizer trials in the interest of augmenting non-conventional energy sources and efficient use of scarce ground water. (Para 2.11)

3. *CASUARINA* MORTALITY

The widespread conviction that *Casuarina* plantations suffer high mortality in the second or third year does not appear to be wholly unfounded. This aspect merits study. (Para 2.14)

4. INTERCROPPING

The efficiency and economy of intercropping with different cash crops in comparison with *Casuarina* planting without it should be taken up for study since a good portion of irrigated *Casuarina* area is not intercropped. (Para 2.15)

5. CLONAL SEED ORCHARDS

The genetic variations regarding growth rate and form are striking in private plantations. Here there are plus trees two to three times the average girth of crop. There is a great scope for production and supply of genetically superior seeds for typical situations (black, red loam, sandy soils) by developing clonal seed orchards. (Para 2.05)

6. SUPPLY OF QUALITY SEEDS

A good production system in the form of private kissan nurseries on their own steam exists. They should be supplied with quality seeds, for that will go a long way in stepping up the overall production in the districts. (Para 2.04)

7. MENSURATION STUDY

Estimation of growth is still a bit of a gamble. The grower and the buyer both are happy the gamble has paid off. By way of introducing a modicum of scientific treatment into the matter the rapid study included a mensuration exercise leading to the preparation of Volume Tables and Weight Tables as ready reckoners in plantations of 48 months in black soil under rainfed conditions and plantations of 72 months in red soil under irrigated conditions. This is probably the first time that *Casuarina* plantations have been taken up for mensuration study. The tables are given in Annexure I. A more detailed study covering different situations remains to be done.

PROSOPIS JULIFLORA

THE TRACT

Physical Features

1.01 But for isolated hillocks a stretch of 24,045 sq.km falling in five districts (Kamarajar, Nellai-Kattabomman, Chidambaranar, Pasumpon Thevar Thirumagan and Ramanathapuram) is a contiguous flat terrain stretching from the foothills of the Western Ghats and generally sloping south-east towards the Gulf of Mannar. It is drained by 15 rivers flowing into the Gulf of Mannar and the Palk Strait namely Hanuman Ar, Nambi Ar, Karamani Ar, Pachai Ar, Manimuthar, Tamparabarani, Malattar, Vaippar, Gundar, Vaigai, Uppar, Sarugani Ar, Virusuli Ar, Pambar and Vellar. Of these the Tamparabarani and the Vaigai systems are the most important. The types of soils are black soil, red loam and sandy coastal. Rainfall is 800-900 mm, 45 per cent during the North-east monsoon (October-December) and the rest during the South-west monsoon (June-September) and winter and hot seasons (January-May).

Agriculture

1.02 The total net sown area (1989-90) is 9,42,200 ha the irrigated area being 3,47,900 ha, the rest 5,94,300 ha (63 per cent) is rainfed. The cultivable waste is 91,000 ha, and other fallow lands 3,89,900 ha adding up to 4,80,900 ha. All this together with rainfed agricultural lands comes to 10,75,200 ha. The common crops cultivated are cholam, cumbu, ragi, cotton, sunflower, chilli, paddy, gingelly, senna. Wherever irrigation is possible they are cultivated as irrigated crops as well. The total area under irrigation works out to 15 per cent of the total area of the tract of 24,04,500 ha.

Population

1.03 The total population (1981) of the five districts is 6.9 million, rural 68.4 per cent (4.7m), urban 31.6 per cent (2.2m). Scheduled Castes constitute 20.1 per cent of the total rural population of 0.95 million.

ANIMAL HUSBANDRY

2.01 Animal husbandry has evolved itself as an indispensable adjunct to the kind of climate and agriculture prevailing. The population of livestock has been rising. The landless rural poor and small land-holders rear goats (9,86,400) and sheep (14,71.100) for penning and sale. Cattle (10,70,200) and buffaloes (3,53,700) serve as milch and draught animals also. Animal husbandry is a traditional occupation as well as an important economic activity. The small farmers, unable to afford even subsidised fertilizers, rely heavily on dung and droppings of animals secured by penning them in their lands. They also pen them in lands of others for some amount varying from a few paise to 50 paise per head per night.

Herd Management

2.02 A case of individual flocks of 16 owners joining and moving as a single herd of 800 heads of sheep and goats was studied. The number offered for sale ranged from 100 to 150 a year

depending on situations. This has some relationship to the annual recruitment of new borns to the herd. The animal keepers said they maintained a steady number of 800 head over the years despite annual sales, deaths due to disease etc. The annual harvest came to 12.5 to 18.75 per cent of the total livestock fetching Rs.30,000 to Rs.45,000 at Rs.300 per head of about one year. Penning is active during eight dry months and at Rs.50 for 800 heads per night and fetches Rs.12,000 a year.

Prosopis Pod as Stockfeed

2.03 Before *Prosopis* was introduced agricultural waste, residue and other weedy shrubs formed the feed. Now *Prosopis* plays an important role providing pods as feed almost throughout the year. It is also free. A well developed *Prosopis* growth can yield four or five quintals a hectare, so about 1.5 lakh tonnes is available in this tract.

DISTRIBUTION

3.01 Our study took into account the presence of *Prosopis juliflora* mainly in the five districts mentioned above. Its occurrence west of NH7 was of very little socio-economic significance. The triangle bounded by NH7 (Madurai to Kanyakumari, 240km), NH49 (Madurai to Mandapam, 120 km) and the coast of the Gulf of Mannar falling in the districts can well be termed as a *Prosopis* Triangle where the species is a prominent component of the landscape and exerting a powerful socio-economic impact on the rural poor. It also occurs north east of NH49 in Ramanathapuram and Pasumpon Thevar Thirumagan districts. As one moves into Pudukottai and Thanjavur districts from Pasumpon Thevar Thirumagan district, one notices sparse occurrence of *Prosopis*, restricted to stream courses and road margins.

Rivers and Tanks

3.02 The distribution is not even within this triangle. It is concentrated along the courses of fifteen rivers and streams, particularly in the lower reaches. Good moisture and good deep soil on river banks support dense growth. Black soil even under rainfed conditions provides the best growth. It spreads to river beds and forms thickets (Tamparabarani river near Srivaikundam) interfering with the discharge, thereby threatening the safety of the banks. There are nearly 10,000 irrigation tanks in these districts. Some are system tanks connected to rivers and canals, and get supply during times of plenty. Many non-system tanks collect mostly runoff water during rains. The total area of tanks is likely to be considerable. They used to be areas of good natural stands of *Babul* in the past. Of late *Prosopis* has been spreading fast to tank beds. The tanks of Kamarajar, Ramanathapuram and Pasumpon Thevar Thirumagan districts receive water supply for one year and remain without supply for the next two or three years. *Prosopis* grow in there tank beds, suppressing the *Babul* plantations raised (Kelapasalai tank near Manamadurai). In Nellai-Kattabomman the tanks receive water fairly regularly and this has kept *Prosopis* away to a great extent.

Rail and Road Margins

3.03 The other areas include margins of railway tracks and network of roads Thirunelvely-Sivalperi – Nalu road, Vaipar – Vembar – Vilathikulam – Ettayapuram – Yepothumvendran – Kadambur – Kayattar – Thirunelvely, Thirunelvely – Sattur – Irrukkangudi – Nenmani – Masarpatti – Melkaranthai – Aruppukottai – Tiruchuli – Parthipanur – Paramakudi, Paramakudi – Vembakkottai – Sattur – Thulakkappatti, Pudukottai – Tirumayam – Tirupattur – Melur, Tirupattur – Sivagangai, Sivagangai – Manamadurai, Mudukulathur – Kamudi – Aruppukottai, Mudukulathur – Perayur – Kovilankulam – Perunazhi – Vilathikulam, Ramanathapuram – Idambal – Sayalgudi – Kovilamkulam – Kamudi. Assuming that five metres as margins on either side of the roads are available the area may be several thousand hectares.

Poramboke and Private Lands

3.04 The adjoining poramboke and private lands carry extensive blocks of *Prosopis* growth, sometimes as far as the eye can see, in Sivalperi of Nellai-Kattabomman, Vilathikulam taluk of Chidambaranar district, Sattur taluk of Kamarajar district, Kamudi, Paramakudi, Mudukulathur, Tiruvandanai taluks of Ramanathapuram district, Manamadurai and Sivaganga taluks of Pasumpon Thevar Thirumagan district. Summing up, the river and stream courses, tanks and road margins and adjoining lands have all come under *Prosopis* and the invasion continues because of various factors.

Phenomenal Spread

3.05 *Prosopis* is an exceptionally aggressive weedy type and grows readily from seeds and regenerates by suckers and coppice. It possesses a network of lateral roots and deep taproots. It comes up well in good soil(black soil) and good moisture situations. It grows in saline also although the growth is not much. It is capable of invading abandoned salt pans, as seen near Devepatnam, in less than eight years. Rainfall as low as 400 – 500 mm is enough to support fairly good growth. Cultivable waste, fallow lands and even lands continuously under cultivation, but left fallow for a season, are invaded and overrun in three to five years. Farmers have to strive hard to keep this species off their holdings. No pest capable of checking its spread has been reported.

3.06 Other contributory factors which promote its spread are as follows :–

1. The pods, available any part of the year, are avidly eaten by cattle and their droppings widely scattered, the seeds fall mostly along water courses and road margins.

2. The seeds are carried by run-off water and spread over greater distances.

3. The application of farmyard manure containing droppings is a common practice. Heaps of manure act as *in situ* nursery beds producing thousands of seedlings even before ploughing starts.

4. These districts were hit by draught in 1982, 1983 and 1987 and those farmers who were not able to resume agriculture had no other option than letting their lands to be covered by *Prosopis*.

5. The high cost of agricultural inputs, particularly fertilizers and the increasing labour scarcity due to other gainful activities (safety matches, beedies) in individual homes in a much better work environment have resulted in shrinkage of agricultural activities.

6. Many absentee land owners away in foreign countries, do not choose to cultivate and their lands are invaded by *Prosopis*. The wood is sold to charcoal manufacturers.

7. *Prosopis*, once considered a casual wasteland species and a nuisance, has now became a cashcrop and a marketable commodity. The species comes up well with no input and care so the poor as well as rich farmers encourage its growth.

Private *Prosopis* Plantation

4.01 *Prosopis* introduced by the Agricultural department in the fifties for serving as a live fence is a rare case of phenomenal growth, and defies all human efforts to exterminate or contain it. The term husbandry, which means farming, is not quite apt to this species at present. The activities are not concerned with its regeneration, tending or planned cycle of felling but concentrate on exploitation and downstream activities like charcoal making.

4.02 We came across one case of *Prosopis* farming. In Thereruveli village (Mudukulathur taluk of Ramanathapuram district) a school teacher raised a small plantation on his rainfed land of 80 cents. In 1990 ragi was raised. The natural regeneration of *Prosopis* seedlings was so profuse due to application of farmyard manure that he gave up weeding after a few attempts to save his ragi crop. After the ragi harvest the residuary *Prosopis* had grown into a dense crop, two or three metre tall, with 12 stems per plant on an average in 18 months. Impressed by this growth he repeated the

Application of farmyard manure results in profuse natural regeneration of *Prosopis*.

technique on 40 cents in February 1991. The growth was very good, one growth to a metre and a half in seven months.

Forest Department Plantations

4.03 The Forest Department raised pure *Prosopis* plantations on tank beds and in waste-lands. In Melakodamalur (Ramanathapuram district)plantations (2m x 2m) were raised in 1983 and 1987. The 1983 plantation brought for sale in 1991 was estimated to yield six tonnes/ha at the end of eight years. In Perungkaranai tank *Babul* was planted in 1971 on 100 ha at 12x12m. Again it was

replanted in 1983. Past history was not available. The existing dominant growth was *Prosopis*. By sampling the yield estimated was at 18.25 to 20.25 tonnes/ha in heavy growth, 14.14 to 15.75 tonnes/ha in medium growth and 8 to 9.25 tonnes/ha in light growth areas. The average estimated yield was 13.13 tonnes/ha and 100 bundles (3 tonnes) per ha. The *Babul* trees were getting smothered by *Prosopis*. The vast tank of Kilapasalai on the outskirt of Manamadurai, originally planted by *Babul*, was rapidly getting covered by *Prosopis* which has ecological superiority and that this will dominate ultimately not only in tanks but also in drylands is a foregone conclusion.

Plant Density

4.04 In a well covered areas the number of stools varies from 500 to 1000/ha depending on the age and growth vigour. At the time of first felling the number of shoots per stool is about 4 to 5 and increases to 10 to 15 after subsequent fellings. The average height is 5m and girth at ground level ranges from 30 to 90 cm. The average yield as stated by the locals and crosschecked is 10 to 15 tonnes/ha at three years interval.

Eighteen months old *Prosopis* growth out of natural regeneration due to application of farmyard manure

Rotation

4.05 The trees are cut once in three years. The first felling is at this age even if growth is sparse, because the villagers believe that first felling will promote good coppice growth. The second felling is on the close of the sixth year. If the growth is very good or the owner needs cash immediately the interval may be two years, even less. The rootstock is generally uprooted along with the third felling, at times at the second, as the owner wishes. Digging up the rootstock does not go beyond 20 to 25 cm and this leaves a lot of remnants which sprout and put forth coppice shoots. But they are not as good the ones coming from stools.

WOOD EXTRACTION

Estimation of Growth

5.01 It is a common practice that the socially handicapped rural poor mostly Scheduled Castes arrange to buy privately owned *Prosopis* growth by negotiations with the owners. The buyers are such adepts that they fix the price for the entire unit on the basis of the probable number of bags of charcoal that they can get from a particular growth, the prevailing price and season. They seem to have no precise idea about the extent, growth and price per ha.

Organisation of Felling Operations

5.02 The extraction work and often charcoal making is done on team basis commonly by 10 to 12 members who are related or from the same village. One of them organizes the work, the others are paid. The yield of wood varies from 5 to 25 tonnes per ha and in addition bundles of saleable thorny branches(faggot) up to 200. Normally a set of four man-mazdoors and four woman-maz-doors cut and collect billets of one tonne. A woman collects 12 bundles a day. These bundles have special markets in temple towns and villages. The owner is paid Rs. 100 to 130 per tonne and fifty paise per bundle of faggot.

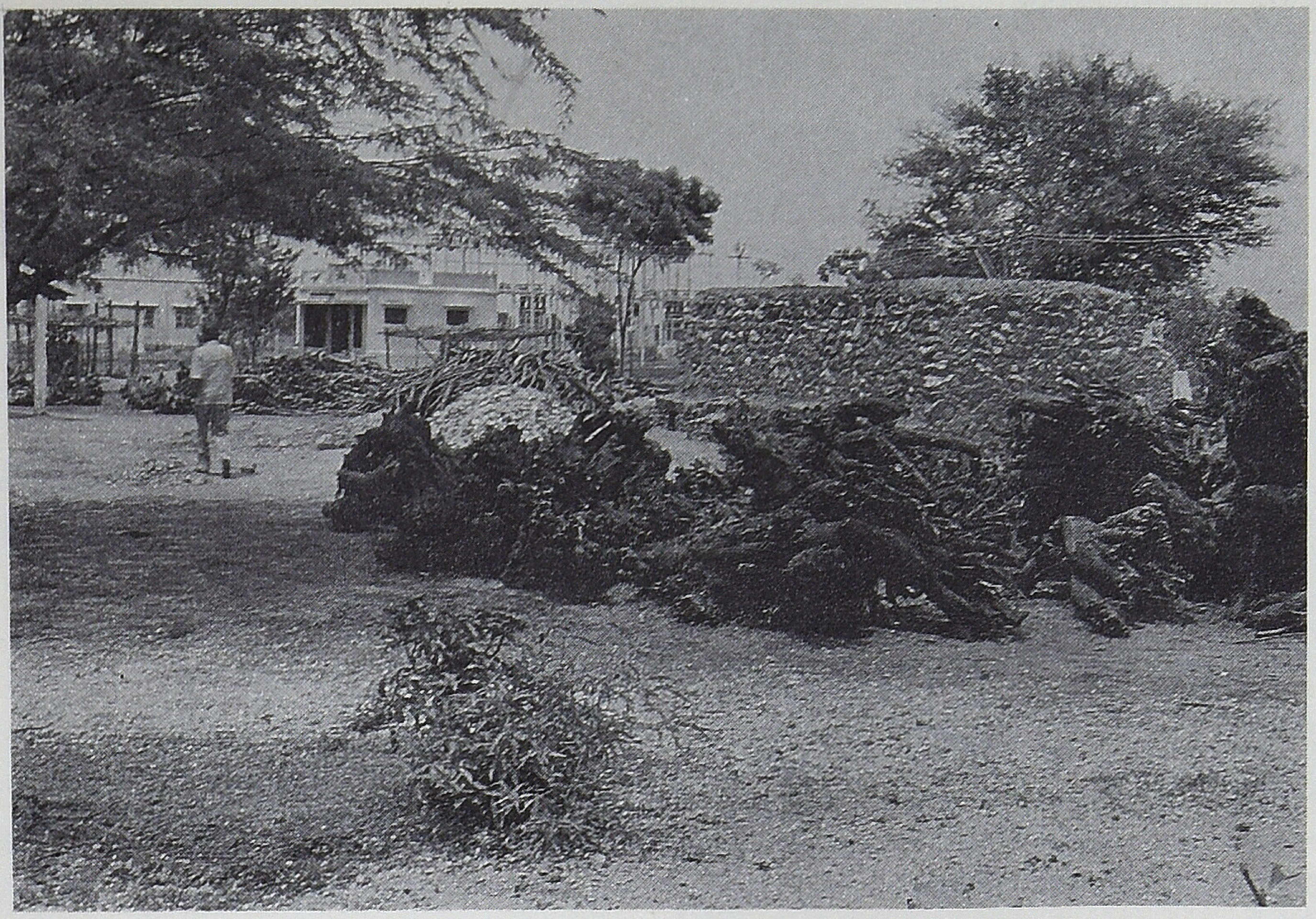
5.03 The prevailing price of wood varies from Rs. 350 to 400 a tonne and faggot Rs. 200 to 250. The cost of production including the price of material paid to the owner is about Rs. 250 per

In Ramanathapuram women toiling on removal of *Prosopis* for *Babul* planting by forest department are vociferously protesting against replacing *Prosopis* by *Babul*. A genuine and meaningful protest.

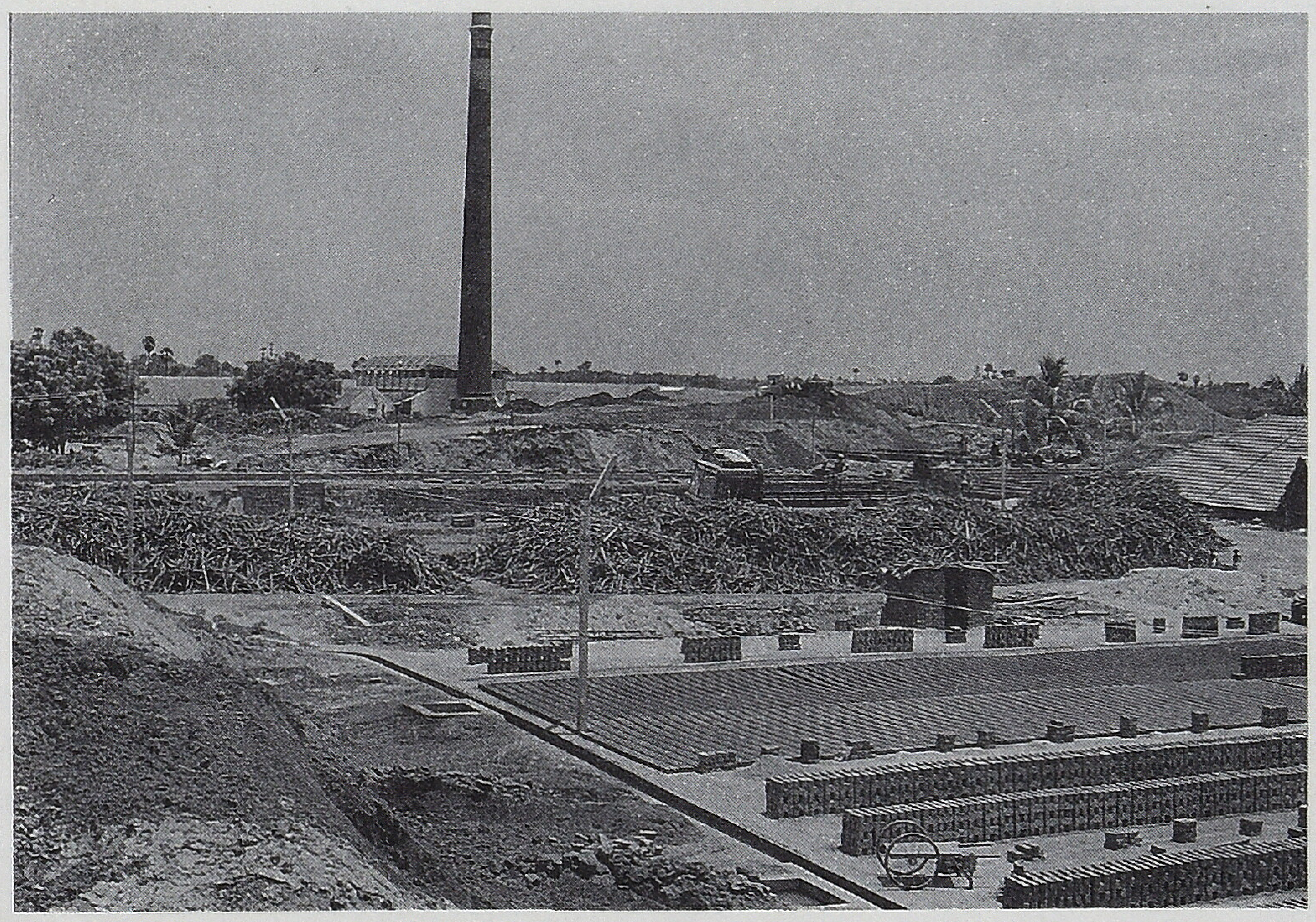
tonne. To this is added cost of loading, cart/lorry hire, brokerage etc. Sometimes a sale takes place at collection centres located in villages, the merchants take it by lorry to distant towns and cities. Headloads mostly from Poramboke lands are also sold to these merchants. In the market the sale of fuel is in different categories and quantities and it meets the needs of a variety of consumers, mostly wage earners.

BRICK MAKING

6.01 An important wood consuming activity is brick making. There are 48 chambers in Madurai and Ramanathapuram districts and 500 brick kilns in Nellai-Kattabomman, Chidambaranar and Kamarajar districts. *Prosopis* firewood requirement is of the order of 1,30,000 tonnes per annum.



Prosopis root stock is the common fuel for lime kilns.



Prosopis billets is the main fuel for brick and tile factories in Ramanathapuram district.

Prosopis brush wood is the fuel for pottery cottage industries in Ramanathapppuram district.

CHARCOAL

Charcoal making Attractive

7.01 Although *Prosopis* firewood of different kinds is a readily salable fuel the demand for *Prosopis* charcoal is steadily growing in distant markets and has become a popular urban fuel. The other reasons are :–

1. The process as practised on small scale makes use of wood of smaller dimensions (about 3 cm diameter) which otherwise will not sell.

2. Charcoal making provides continued employment.

3. The product, depending on the efficiency of the process, may go up in unit value marginally or end in loss. Even without a profit the advantage is that villagers are sure of earning their livelihood.

Charcoal Process

7.02 Charcoal is the residue of wood as a result of heating it to high temperature in a closed space without free access of air and allowing it to cool on its own without entry of air. During the process the wood becomes bone dry at 110'C and further rise to 300'C initiates pyrolisis, which breakes down the wood into water vapour, gases, wood acids and tars with the evolution of heat resulting in charcoal. Burning the wood correctly is the key to efficient manufacture. This venture gives employment to a great number of abysmally poor people.

Charcoal Composition

7.03 Good commercial charcoal analyses as follows: Fixed carbon 72 per cent, volatiles 17 per cent, moisture 8 per cent and ash 3 per cent. The percentage of fixed carbon and volatiles may vary depending on the maximum temperature attained during the process.

Charcoal making

7.04 The team which has collected the wood usually converts it to charcoal. The process is generally on a small scale (50 to 150 bags of 45 kg each) of charcoal and takes place at the felling site itself. A minimum of 10 to 30 tonnes wood is required. The traditional method starts with stacking the wood hemispherically at ground level, the height varying from 30 cm to 90 cm. The stacking is time and wage consuming and requires skill. The large rootstocks are piled at the core, followed by billets of several layers and finally sticks roughly in the ratio of 20:70:10. This is covered by paddy straw or sugarcane trash and finally sealed by a layer of 10 to 20 cm of thick earth. An opening is left at the top for the lighting the stack and for the smoke to escape and a number of air holes are opened around the base. The stack is lit by throwing in burning charcoal. The carbonisation lasts five to seven days depending on the quantity and the skill in regulating it. As the process advances the stack shrinks and cracks, holes appearing. Sometimes water is sprinkled to prevent the fire form getting out of control and burning up the charcoal. The cooling in this method is not natural but done prematurely by dousing the heap with water at the end of carbonisation as judged by the issue of clear smoke. It is the practice to open the heap while it is still hot and this is technically incorrect resulting in lower output due to exposure to air.

Stacking of *Prosopis* wood is skillfully done with an artistic touch with rootstocks at the core followed by billets and finally sticks in proportion 20 : 70 : 10

Water as an Input

7.05 Water, a critical input in this method, often determines the location of kilns. Water scarcity in the tract is so well known that in one case a kiln had to be located near a drainage system. The villagers say that dousing with saline water lowers the quality of charcoal. Often using water becomes expensive, for it has to be carried over a long distance.

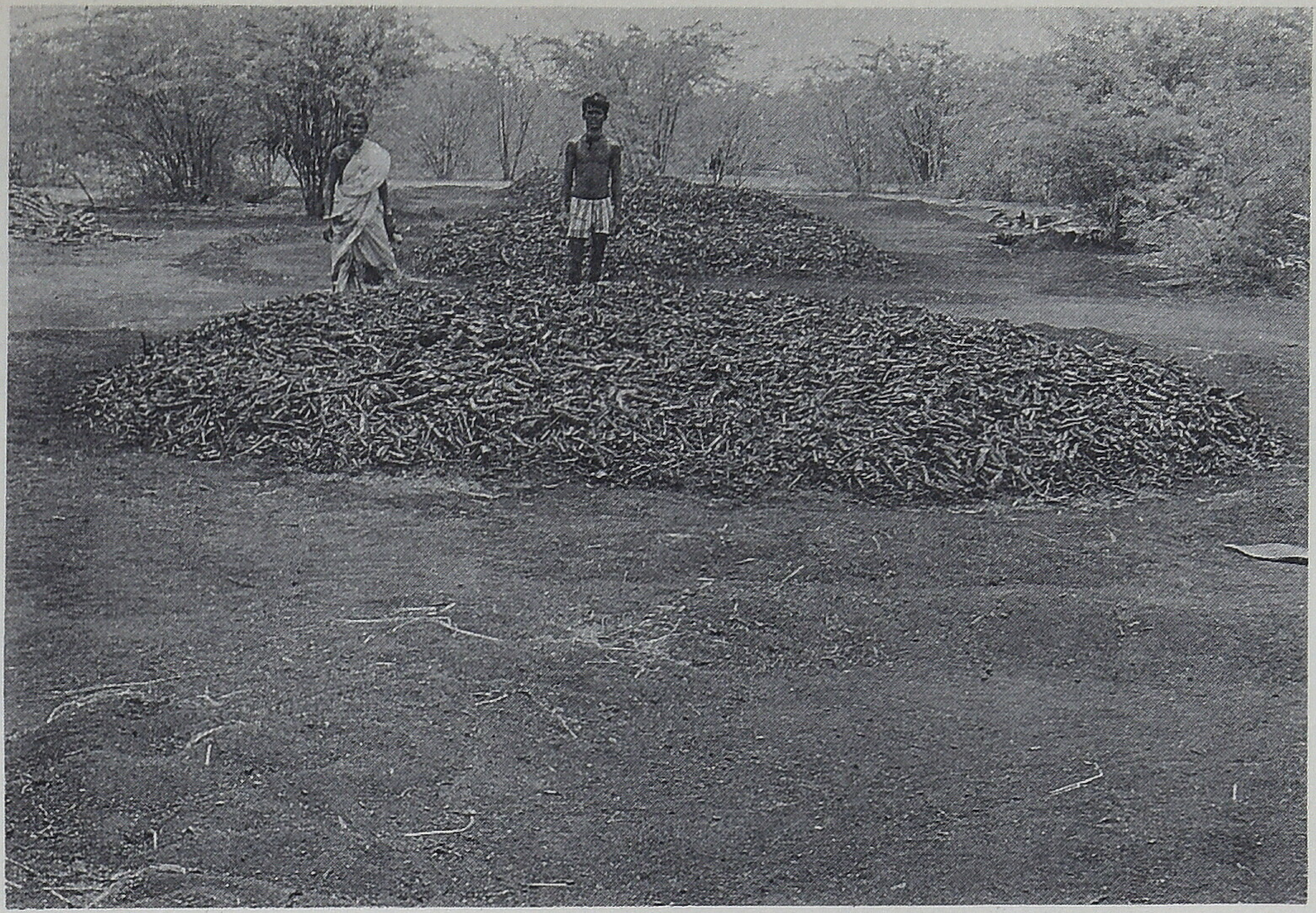
Cost Break-up at Temporary Sites

7.06 Based on data from different sources – kiln operators, brokers and merchants – the approximate cost break up for 100 bags of charcoal (4.5 tonnes) including labour component is given below :–

Prevailing wages : Rs. 20/- per man-mazdoor (Mm) and Rs. 10/- per woman-mazdoor (Wm)

Estimated wood requirement 20.5 tonnes at Rs. 130 per tonne							Rs. 2,665
	Mm	Wm	Rs. Mm	Rs. Wm	Total Rs.		
Cost of felling and collection at 4 Mm and 4 Wm per tonne for 20.5 tonnes	82	82	1640	820	2,460		2,460
Charcoal making a) Stacking	3	15	60	150	210	270	680
b) Mud plastering	2	2	40	20	60	39.7 %	
c) Firing & regulating (5 days)	5	2	100	20	120	210	
d) Cooling and opening kiln	2	5	40	50	90	30.9 %	
e) Sorting	2	4	40	40	80	200	
f) Bag filling	2	8	40	80	120	29.4 %	
TOTAL	98	118	320	360	680		5,805

Dousing the heap with water to prevent fire from getting out of control. Water is an expensive input.



Charcoal spread after opening of the heaps

Cost of production of charcoal	Rs. 1290.00	per tonne
Cost of production of charcoal	Rs. 58.05	per bag
Selling Rate	Rs. 60.00	per bag
Profit	Rs. 1.95	per bag
NET profit for 100 bags	Rs. 195.00	
ADD price of two bags for moisture content	Rs. 120.00	
TOTAL PROFIT	Rs. 315.00	

NOTE.— A certain quantity of broken and fines are always available, but the price is not included. If charcoal output is lower than expected for more than one reason, say a slump in the market, the operation may result in loss. Addition of water and keeping the charcoal as moist as possible till weighment is a very common trade practice. Other methods of cheating include buying from small producers by forcing a standard deduction in weight for assumed dryage at 100 kg per tonne of rootstock, 50 kg per tonne of billets, etc., irrespective of the condition of the wood. Grading is also not strictly followed lower grades charcoal is mixed with higher grade. Such malpractice is found at various levels, so it is difficult to work out the true economics of this activity.

Implications

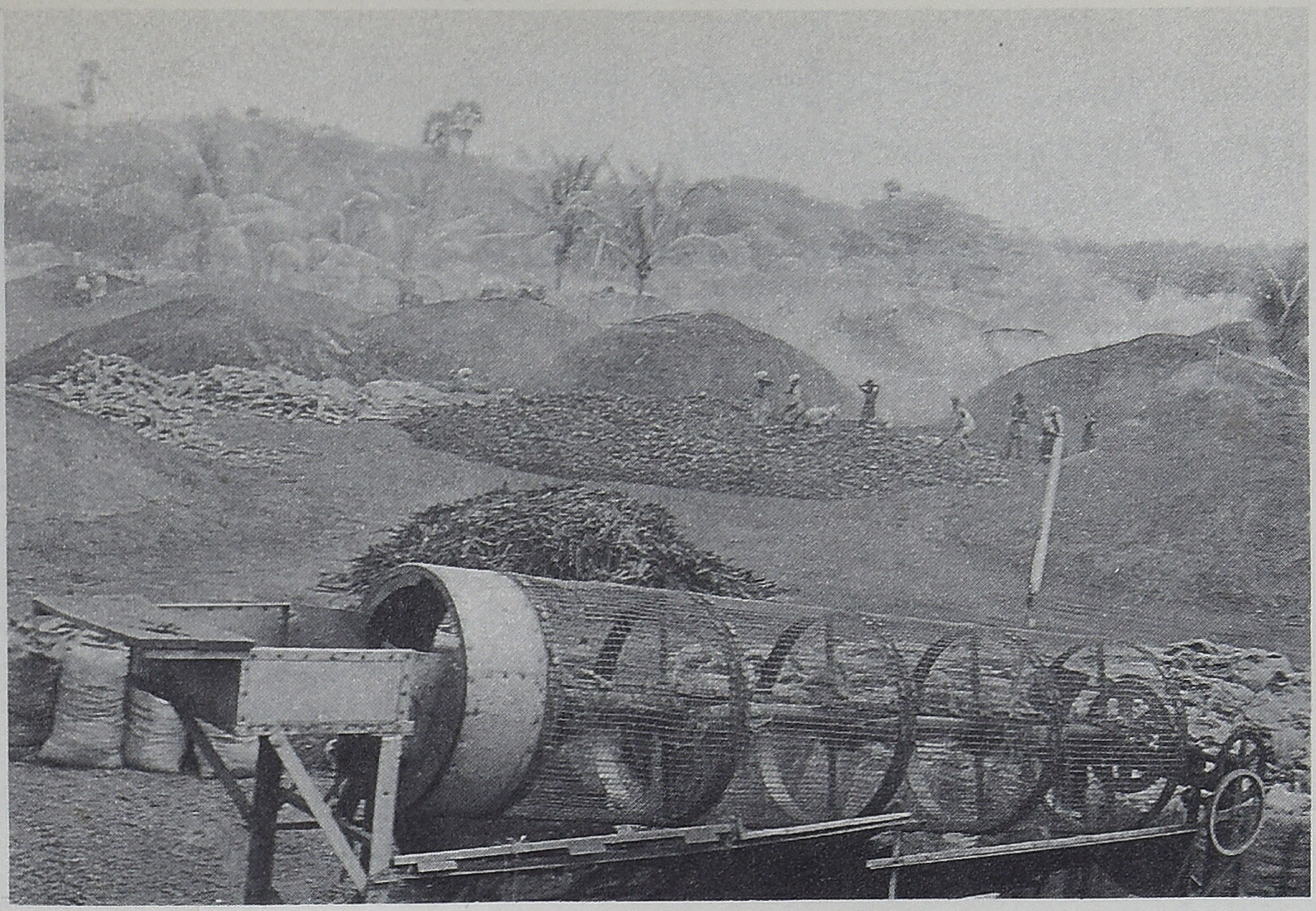
7.07 A break-up reveals that the cost of material comes to 45.90 per cent and production cost 54.10 per cent. The cost of felling and billeting works out to 78.30 per cent of the total cost of production and this needs reduction by better planning and execution. Charcoal making is 21.70 per cent of cost of production. Although this appears reasonable (11.7 per cent) in overall cost it can be reduced under items stacking and mud plastering. The employment potential is 98 man-days and 118 woman-days amounting to Rs.1,960 and Rs.1,180 respectively. A team of 10 to 12 persons carry on such operations at least 10 times a year and the total amount earned by way of wages is Rs.31,400, the cost of materials Rs.26,650 and of the product Rs.60,000 at site. If all the operations are successful (which is seldom possible) the total gain will be Rs.3,150 per annum which includes Rs.1,200 for 20 bags of added moisture to the charcoal. Probably the gain is mopped up by the interest to be paid to the creditors. Finally the whole activity boils down to a poverty alleviation measure under self employment. Nevertheless the workers feel proud.

Uses and Endusers

7.08 The small scale producers sell to intermediaries and merchants who bear the cost of gunny bags and transport. The merchants pool their stock and sell to bigger merchants who export it to other states or sell to industrial units or consuming centres directly. They do not seem to know about the end uses and endusers.

7.09 Kilns of larger capacities are organized in sites taken on long lease. Necessary infrastructure consisting of wells, pumps, electricity and mechanical devices for grading charcoal are provided. Large size stacks are more efficient due to lower ratio of surface area to volume. This reduces the effect of air leaks and heat loss. Wood is delivered at site by different suppliers and the prevailing cost is Rs. 360 per tonne. Wood 80 per cent of which is more than 15 cm diameter is used and nothing less than 5 cm diameter is accepted. The use of large size billets and better organisation leads to higher output. Cost of wood at Rs.360 a tonne comes to Rs.73.80 per bag and charcoal making and bagging Rs. 9 inclusive of a profit of Rs. 2 per bag, and cost of gunny bag and cover Rs. 6.60 totalling Rs. 89.40. Charcoal is transported from this region, particularly Pasumpon Thevar Thirumagan and Ramanathapuram districts to Gujarat, Maharashtra, (mainly Bombay Metropolis), Kerala and Karnataka States.

Kiln of a larger capacity working round the year and exporting charcoal to other States.



Grader to separate different categories of charcoal

Charcoal Production

7.10 There are many charcoal making units in Parthipanur, Paramakudi, Kamudi, Mudukulathur and Rajapalayam. The biggest is near Manamadurai on NH49. It is located in a big rented site of a few acres. It employs 150 man-mazdoors and 350 woman-mazdoors a day, the number varying with seasons. The wages paid are Rs.25 per man-mazdoors and Rs.10 per woman-mazdoors. During the rainy season (June to November) when charcoal manufacture cannot be carried on in Gujarat and Maharashtra, about 19,000 tonnes of charcoal and off season (December to May) 10,000 tonnes are exported to those States.

7.11 It is estimated that 1,36,000 tonnes of charcoal is produced per annum the approximate break-up being 30,000 tonnes from Parthipanur, 24,000 tonnes each from Paramakudi, Kamudi, Mudukulathur and Vilathikulam taluks and 5,000 tonnes each from Rajapalayam and Sivalperi areas each.

Commercial Grades and Demands

7.12 Charcoal falls under four commercial grades. The first grade contains pieces 2.5 cm diameter and above and goes to distant markets in Gujarat, Maharashtra, Karnataka and Kerala, the price being Rs.1,500 to 2,000 a tonne. Two other grades below have pieces less than 2.5 cm diameter and are consumed mainly by local lime kilns and costs Rs.800 to 1,100 per tonne. The fourth grade, called mud grade, has brokens and fines mixed with earth and is sold as such. The charcoal removed by sieving is bought by agarbathi manufacturers. Commonly charcoal is used for drying, raising steam and smelting of metals. It is consumed at Hospet (60,000 tonnes) Harihar Polyfibre (20,000 tonnes) and Bhadravathi steels (50,000 tonnes). It is used in carbide and ferro-silicon industries. It is a much sought after fuel in houses.

BREAK-UP OF TOTAL *PROSOPIS* ACTIVITY

8.01 In our rapid study, we had to depend necessarily on information collected from persons in the trade, villagers and workers and meagre information. After a careful examination of this pooled information the following figures are given below :–

I – ESTIMATED ANNUAL PRODUCTION OF *PROSOPIS* FIREWOOD AND CHARCOAL OF THE FIVE DISTRICTS

Category	Charcoal in tonnes	Wood in tonnes	Probable *Prosopis* area at 15 tonnes per hectares
Firewood			
a) Domestic consumption (Rural and Urban)		5,36,526	35,768
b) Brick Kilns		1,30,000	8,666
Charcoal			
a) Tea shops, etc.	20,000	1,00,000	6,666
b) Commercial mostly for export to other States	1,36,000	6,80,000	45,333
TOTAL	1,56,000	14,46,526	96,433

Domestic consumption in terms of wood is 5,36,526 tonnes (37 per cent), tea shops etc 1,00,000 tonnes (7 per cent), industrial and commercial purposes 8,10,000 tonnes (56 per cent).

II – ESTIMATED ANNUAL CUT AREA (96,433 ha)

Total area for a three year cycle of cutting 2,89,299 ha or 3,00,000 ha. If the probable average is 10 tonnes/ha, the area may be 4,50,000 ha. It works out to 12.5 per cent to 18.7 per cent of the total tract of 24,04,500 ha and is very likely to be found in tank beds, poramboke and private lands, rivers and road margins.

III – EMPLOYMENT POTENTIAL

	Man-days	Woman-days
Extraction of wooded growth	5,76,104	5,786,204
Charcoal making	5,54,666	1,248,000
	6,340,770 or 6.34 million	7,034,104 or 7.03 million

IV – ESTIMATED ANNUAL WAGES

Man-mazdoor at Rs. 20 a day	Rs. 126.8 millions
Woman-mazdoor at Rs. 15 a day	Rs. 105.5 millions
TOTAL	Rs. 232.3 millions

A hectare of *Prosopis* provides wages Rs. 2,323 per ha on a three year cycle or a notional annual wage accrual of Rs.774 per ha.

CERTIFICATE OF ORIGIN

9.01 Based on the representation of charcoal merchants, the Tamil Nadu Government authorised in their G.O. Ms. No. 6 Forests and Fisheries, dated 3rd January 1986, District Forest Officer or any officer authorised by him to issue a certificate of origin for the transport of charcoal to other states after verifying the genuineness of its origin. In a subsequent letter No. 7075 / FR13 / 86, dated 4th April 1986, the government ordered a nominal fee of Rs.5 per certificate for one lorry load. The Chief Conservator of Forests of Andhra Pradesh, Karnataka, Madhya Pradesh were informed that the certificate of origin may be accepted as a valid pass for interstate movement of charcoal. The Chief Conservator of Forests (Tamil Nadu) directed that exchange of certificate of origin for Form III permits be made at the check-posts on interstate boundaries.

9.02 Discussion were held with charcoal producers about difficulties in implementing these orders. One problem was satisfying the issuing authorities about the origin. Charcoal is prepared at the felling sites by small producers who are constantly on the move. They sell it at their sites or cart it to bigger producers who buy it, pool it and grade it for transport to other states. The same thing holds good for wood which bigger producers buy from different sources and convert it into charcoal. The small producers are not able to give any information about survey numbers, much less certificates from the village officers. The charcoal making process is a gamble and traders find they cannot afford even the "incidental expenses" incurred in getting a permit. It is true that big merchants are unable to gather particulars lot-wise as and when they buy. *Prosopis* is still very much a private resource and the rules have to be implemented imaginatively. Otherwise it will throw many particularly Scheduled Castes out of work.

MONEY LENDING AT EXORBITANT RATES

10.01 For example a small trader finds some working capital, invariably by borrowing at exorbitant rates of interest ranging from 36 to 60 per cent with security and 120 per cent without security. The period of repayment is two to three months. The banks never lend. This kind of usury is rampant in the village, but it is the way of rural life. It is commendable that the poor are keen to remain creditworthy even under difficult conditions and managed to stay in business. It will be worthwhile to gain an insight into these dealings which may run to many lakhs of rupees for evolving alleviation measures.

BULLOCK-CART TRANSPORT SYSTEM

11.01 Wood and faggot are carried to nearby towns and consuming centres (20 to 30 km away) mostly by double bullock-carts. *Prosopis* having become a major source of fuel since the late seventies, has gone a long way reinforcing the bullock-cart system. The owners also make good money hiring the carts. They get loads 100 to 120 times a year for transport, earning Rs. 10,000 to 12,000, the net profit being Rs. 3,600 to 5,600 per annum. Village artisans (carpenters, blacksmiths) too benefit from carrying out repairs to the carts.

Bullock-cart owners are able to ply their trade and earn a decent income due to *Prosopis*.

VILLAGERS' INNOVATION

12.01 In Vilathikulam taluk (Chidambaranar district) *Prosopis* was so much favoured that the villagers adopted an ambitious scheme. They conceived the unique idea of collective ownership of land with or without *Prosopis* growth. Lands included are those long left fallow,or situated at the tail end of uncertain irrigation, or surrounded by inexorable aggressive *Prosopis* or which had suffered uncontrollable grazing and so unfit for any other crop. *Prosopis* established itself very well in black soil. In one instance in Vilathikulam taluk a tank breached in 1978. No help was forthcoming from governmental agency. The villagers with a small fund of their own took on lease *Prosopis* growth in Panchayat lands and made a handsome profit. This inspired them to buy up the lands mentioned above as and when they came up for sale. So far they have bought 160 ha of *Prosopis* lands close to their village. The sale deed was registered in the names of respected and trustworthy elders of the village by common consent with explicit mention of the use of growth on the said land for the purpose of village common good.

In 1990 they earned Rs. 25,000 from the sale of growth and spent it on renovation of a temple. The idea caught on. In Pallakulam out of *Prosopis* sale proceeds of 100 hectares, Rs. 2,000/- was paid to each family. In 1983 in Velayudhapuram sale of *Prosopis* growth on 200 hectares fetched Rupees four lakhs and with that amount a marriage hall was constructed. This is rented out at Rs. 100 a day. In Melmadai the sale proceeds of produce from 80 hectares came in handy to put up an office building for the Pethanachiamman temple and a welcome arch at the entrance to the village. *Prosopis* has promoted a sense of belonging to the village, and co-operation transcending caste and political divisions and motivated them for productive and profitable work.

CASUARINA EQUISETIFOLIA

THE TRACT

Physical Features

1.01 The study of *Casuarina* was confined to Chengalpattu – MGR and South Arcot districts (18,758 sq.km). The tract is coastal flat terrain dotted by isolated hills and drained by a few rivers, the important being the Palar, the Ponnaiyar, the Ghadilam and the Vellar. The rivers are usually dry and carry little flow for a few days during the North East monsoon. The rainfall varies from 800 to 1,200 mm, more in coastal areas. The soil types are mainly Black and Red Loam and Sandy Coastal in some places.

Population

1.02 The population according to the 1981 census of both districts was 7.8 millions. 73.6 per cent rural; Scheduled Castes formed 19 per cent of the total population of whom 83 per cent is rural.

Agriculture

1.03 The net sown area in Chengalpattu – MGR district is 2,65,368 ha (77.2 per cent irrigated) and in South Arcot districts 5,68,103 ha (50.7 per cent irrigated). The important crops are paddy, sugarcane, groundnut, cumbu, cholam, gingelly and coarse millets, the first two irrigated, groundnut mostly unirrigated and the other crops almost rainfed. The irrigation infrastructure consists of government canals 5,168 km tube wells 47,661, ordinary wells 2,27,014 and tanks 6,305, besides eight resorvoirs irrigating 4,92,374 hectares. Cultivation is heavily dependent on groundwater through wells to the extent of 60 per cent and canals 12.8 per cent.

Changes in Land Utilization

1.04 During the past four decades there had been changes in land utilization and cropping patterns in the State due to various reasons. Increasing pressure on land led to the shrinkage of certain classes of government land (permanent pastures and other grazing lands less by 22,774 ha, unculturable lands by 39,175 ha and cultivable waste by 4,126 ha in the five years ending 1989-90) at State level as per the Season and Crop Report 1989- 90 of the Director of Statistics, Madras. It is likely that much of this diverted land in the recent and distant past was cultivated and the two districts are no exception.

Cropping Patterns

1.05 The cropping patterns are primarily determined by soil and climate. There is a close relationship between the amount of rainfall and the area of cultivation under various crops. In 25 years (1960 to 1984-85) the rainfall was below normal for 14 years. This led to a sharp decline(16 per cent in 1968-69) in the area under food grains compared to the previous year. The fall in cultivated area was 14 per cent in 1974-75, 19 per cent in 1980-81 and 16 per cent in 1982-83. A similar trend was noticed for groundnut, the area cultivated fell by 13 per cent in 1974-75, from the previous year, 16 per cent in 1980-81 and 12 per cent in 1982-83(Tamil Nadu Economy, MIDS, 1988).

1.06 From time to time there had been a shift in cropping patterns conditioned by several factors, mainly economic. Farmers switched from low cereal to high value paddy because of expansion in the irrigated area was noticed. But in the seventies sugarcane which was more remunerative was observed. Even under rainfed conditions groundnut is more profitable than cholam and cumbu, hence a larger area under groundnut during the favourable seasons.

Casuarina Attractive and Remunerative

1.07 The weather-induced fluctuations hit the small farmers hard. To them *Casuarina*, is a worthwhile investment. There are many reasons favouring *Casuarina*. Though a tree, it is a suitable short rotation cash crop and the cash can be had any time. It needs only a small capital to start with and very little recurring expenditure. Small farmers plant their holdings (often a few cents) and seek out wage labour. Tree husbandry does not bind them to their holdings. *Casuarina* is an excellent fuel; it is used as poles for centering in buildings, as scaffolding material, hence it commands distant markets. Of late the spurt in building activities, particularly in Madras city, has made *Casuarina* cultivation very attractive and remunerative. Small farmers find it a good means to raise short-term capital money for education, marriage, buying land or a house and paying off debts.

Casuarina Forays into Cropping Patterns

1.08 The cropping patterns and the growing importance of *Casuarina* were examined closely with reference to the two districts. The main crops are paddy and sugarcane under irrigation (4,25,500 ha) and they stay put at this level leaving little room for forays by *Casuarina*. Next in importance is groundnut in 2,26,200 ha (94,100 ha irrigated and 1,32,100 ha unirrigated). Although it is an important cash crop it is a common practice to plant *Casuarina* in the same fields after one or two groundnut crops. *Casuarina* is harvested after three or four years and the cycle may be repeated. The other important unirrigated crops are cumbu (76,600 ha), cholam (23,000 ha), gingelly (30,800 ha) and coarse cereals (13,000 ha) aggregating 1,44,400 ha. The total unirrigated cultivation is of 2,76,500 ha and is open to *Casuarina*. On the whole about 3,00,000 ha (not counting irrigated goundnut area) may be available for *Casuarina*. It is a fact that *Casuarina* had been gaining a foothold in agriculture not only as a cash crop but also as a worthwhile short-term investment for various reasons which go beyond the dictates of climate and market supply and demands.

1.09 *Casuarina* cultivation has been in vogue for decades and we found in our study that the species slotted well into agricultural cropping patterns from time to time (i.e.)after groundnut in one fifth of its cropped area, one twelfth of sugarcane area and one twelfth of dry crop area.

TREE CULTURE

Historical

2.01 It was in the second half of the 19th century when the newly formed railway system was getting established that the authorities were looking for a fast growing tree species as fuel for the steam locomotives. *Casuarina*, introduced about that time, filled the bill admirably and the farmers finding its potential and good market took to its cultivation. This was the beginning of tree husbandry in India. At that time agriculture was more an occupation than a profitable business as it is today and it was not difficult for *Casuarina* to gain an entry into agriculture. It was introduced into India probably in Chengalpattu-MGR and South Arcot districts. Since then it has spread to other districts of Tamil Nadu.

2.02 Unlike *Prosopis*, *Casuarina* cultivation started in agricultural lands and continued in a desultory manner. Growth was based on empirical knowledge. So there were many opinions on plantable seedling size, spacing, population dispersion, cultural operations, rotation, marketing procedures and practices. The object of the study was go into tree farming methods and marketing and reject the wrong and wasteful practices and consolidate the relevant.

Microlevel Consideration

2.03 Examining at microlevel one finds invariably more than one reason for farmers switching to *Casuarina*. Nearly 35 per cent of the farmers in the two districts settled for *Casuarina* mainly due to scarcity of water for irrigation, and 60 per cent of cultivation depends on groundwater in the two districts. Another reason was the difficulty in securing adequate labour in time for harvesting grain. It was found that the 26 per cent of the farmers choose *Casuarina* for this reason. Third the increasing cost of agricultural inputs make 24 per cent of the farmers turn to *Casuarina*. Very few 10 per cent plan to raise *Casuarina* plantations for lumpsum return and fewer still 5 per cent adopted, it is an absentee landlord crop. Sometimes the farmer is influenced by adjacent growers because it will not be possible for him to manage his agricultural crops against damage by rodents and birds and shade and root effects arising out of surrounding *Casuarina* plantations. He gets along with his neighbours by raising *Casuarina* in his land. Such a decision helps him in the disposal of his plantation also.

Kissan Nurseries

2.04 *Casuarina* farming has led to the development of hundreds of private kissan nurseries centred at certain well known villages (Chinna Andikuzhi, Periya Andikuzhi, Alappakkam, Puduchathiram) approached from the Chidambaram – Cuddalore Highway, Poondiankuppam, Nochikkadu, Naduthittu and Devanampatnam of South Arcot district and Aranthagi, Sithamalli and Agaramputhur approached from Kumbakonam – Panruti Highway in Trichi district. This activity has been going on for one or two generations.

Private *Casuarina* nurseries, Andikuzhi, South Arcot district

Private *Casuarina* nurseries, Andikuzhi, South Arcot district

2.05 Beds of different sizes and of loose fine sandy soil are formed either at ground level or 7.5 cm above that. No farmyard manure or fertilizer is applied. Seeds are collected locally without regard to genetical superiority of mother trees. The seed rate is six measures (small) per bed of 400 ft^2 (36.8 m^2). The main expenditure is watering, Rs. 8 a day for watering 1.5 lakhs of seedlings (five beds of 30,000 plantable seedlings each) and the total for five months comes to Rs.1,000 to 1,200. The seedlings at Rs.20 per thousand sell for Rs.3,000; the net gain is Rs.1,800 ,but the total gain is nearly the entire amount since watering is done by the owners themselves, often children. If the selling rate slumps by 50 per cent the net profit comes down very much to, just Rs. 300. That is why the nursery is treated as an ad-hoc affair, being maintained at the barest expense. The net return of Rs.1,800 from five beds occupying five cents of lands is profitable. Nurseries come in handy to farmers to face problems of uneconomical fragmentation of their holdings. They shore up their economy cultivating value added items like vegetables and flowers (gourds, cluster beans). Kundumalligai, a variety of jasmine, on eight cents fetches an annual net return of Rs.11,000. *Casuarina* culture has led to specialised pottery. The speciality of the pots (10 to 12 litres capacity) is the short neck and small mouth facilitating convenient handling. A boy can carry two pots of water. It is 1.5 times costlier than pots of similar capacity; the demand for such pots is limited to Andhikuzhi villages. We found in our study that the species fitted admirably into agricultural cropping patterns from time to time (i.e.) after groundnut in one fifth of its cropped area, one twelfth of sugarcane area and one twelfth of the dry crop area.

Disposal of Seedlings

2.06 The common seedling size for plainting is of 30 to 60 cm height priced at Rs. 20 to 35 per thousand. Some buy them young (10 to 15 cm) at Rs. 4 or 5 and grow them on transplant beds till they are planted. One experienced tree farmer said seedlings raised in certain areas (red soil in Madaveli) are not suitable for planting in his lands in Vadagaram village, (sandy soil) while Pillayarkoil seedlings (sandy soil) are quite good. These places are in and around Marakkanam. Such statements need to be verified to find out if particular seedlings are suitable only to particular types of soils. The disposal of seedlings is commonly by lots of thousand naked seedlings or by beds. Selection of seedlings is allowed for a higher price of rupees two to five per thousand. The farmers buy their requirement directly from nursery keepers or through brokers (brokerage of rupee one per 1000). More commonly it is through traders who buy them and take them to the markets or to those who have booked their requirements with them. The consignments are taken by cycle, bus or train; these seedlings stay good for three days.

Soils

2.07 The soil is 70 per cent black soil, 20 per cent red loam.

Growers

2.08 Of the growers 30 per cent are old timers; nearly 60 per cent are influenced by neighbouring farmers. There is no evidence of the government or private consultancies giving help or guidance.

Spacing and Growingstock Density

2.09 Spacing.—Various spacing measures are adopted 1 ft x 1 ft (30 cm x 30 cm), 2 ft x 2 ft (60 cm x 60 cm), 2.5 ft x 2.5 ft (75 cm x 75 cm), 2.75 ft x2.75 ft (82.5 cm x 82.5 cm) and 6 ft x 6 ft (180 cm x 180 cm). The common spacing is 3 ft x 3 ft. Nearly 80 per cent of planting falls under 3 ft x 3 ft and less. Seedlings are planted one at a spot (4840 per acre) or in clusters of 2 or 3 numbering 9,680 to 14,520. The number could go up to 26,130 per acre depending upon the spacing adopted. Single seedling planting is more common (48.5 per cent) than cluster planting (21.2 per cent) the rest clusters and single.

2.10 Extraneous considerations, not strictly technical, determine the population density. In certain parts (Chidambaram Taluk) planting is done on contract at a rate based on the total number of seedlings planted. Workers insists on cluster planting as they stand to gain. Secondly, there is a widely prevalent notion that a high density population will serve as an insurance against drought mortality without realising that this by itself may cause the greatest havoc. Third, a few farmers, with water and other resources, plant the minimum number because they are confident of getting the crop through drought years.

Farming Practices Fertilizer Application

2.11 Prior to planting the land is ploughed. Even Sandy soils are turned over in a criss cross fashion. Unless the soil is sandy, farmers do not add farmyard manure exclusively for *Casuarina*. Planting is done by a team of three or four labourers on daily wages. Fertilizer application has come to stay for irrigated cultivation on the basis of empirical knowledge or hearsay. It is of different combinations and dosage. Urea 50 kg and complex 50 kg or complex 75 kg + Urea 50 kg or muriate of potash + superphosphate + urea of 100 kg to 150 kg or any other combination. A detailed study into fertilization aspect will have to be taken up.

Weeding and Pruning

2.12 While weeding favours early establishment and a good start, pruning promotes good tree formation and better distribution of usable biomass in the trees. The number of weedings depends upon soil fertility, irrigation support, fertilizer application and cultivation practices and since the variables are too many it is not possible to frame one common weeding schedule. In cases of intercropping the number of weedings will be not less than six in the cropping seasons. According to some growers weeding has a two fold objective - getting rid of unwanted plants and reducing the finer roots near the ground level in order to promote deeper rooting of planted seedlings particularly in sandy soils under rainfed conditions. This theory needs research. The frequency and timing of pruning depends on the density of growth, the first sometimes becoming due as early as the end of the first year or as late as the end of the third year. Pruning is an important cultural operation and needs to be studied with reference to rate of growth and population density.

Watering

2.13 Watering is an important farming operation. While it is a big slice of the total expenditure it results in a higher yield. Watering is done by flooding, by shallow channels or by blocks of 20 to 25 plants with bunds encircling each block. During rainless months the watering frequency may be one to four times a month and in the absence of recorded discharge from wells it is not possible to quantify it. In certain situations (sandy soils) watering alone costs Rs. 1,200 to 1,000 per acre a year. Once watered, the trees will have to be watered till felling. A five year old one acre plantation may cost Rs. 5,000/- for watering. The yield may vary from 30 to 75 tonnes an acre on a 5 to 6 year rotation. The total cost of cultivation will vary from Rs.3,000 to 8,000 per acre.

Early Mortality

2.14 There is a widespread conviction among growers that plantations suffer high mortality in the second – third year. There is an interesting case. In Aruvampakkam village on the Tindivanam - Pondicherry via Kilianur road the owner of a small holding of 70 cents raised *Casuarina* along with gingelly under well irrigation in the last quarter of 1988. After harvest of gingelly the well went dry the following summer and there was no water for *Casuarina*. At the time of our visit in July 1991 the 32 month old plantation was a total failure. The dead plants were uprooted and collected in kalasams (conical heaps) for sale. Surprisingly an adjacent plantation of the same age where there was no well recorded just 25 per cent mortality. Another adjoining piece of land of three acres of similar *Casuarina* was planted with coconut in part of the area after removal of *Casuarina*. The *Casuarina* started with well irrigation but the cocoanut trees has all the irrigation after the first summer. The result was a high percentage of *Casuarina* mortality. Observations elsewhere in South Arcot and Trichy district (Nellitope, Meensurutty) strongly suggest that the popular conviction is not wholly unfounded. It appears that *Casuarina* tends to develop superficial roots under irrigated conditions and is unable to survive when the water level goes down in drought years. Although irrigation is capable of boosting the yield, the risk can be serious if irrigation support is not assured. There are cases of entire plantations dying year after year warranting replanting.

Intercropping

2.15 Intercropping with groundnut, paddy, tapioca, vegetables etc., is not uncommon and is practised in 38 per cent of area under *Casuarina*. It is not done in the remaining area where irrigation is possible. Groundnut is the most popular and profitable crop. The practice is that land with irrigation facilities is cropped twice in eight months (from August to April) and the gross return is Rs. 10,800 an acre for a harvest of 720 kg of seeds at Rs. 15 per kg and a net profit of Rs. 5,600. This need not be taken as a typical case. It is a very attractive remuneration for a six month labour.

Casuarina is planted after the harvest of the first groundnut crop in November – December. At the time of the second harvest in March - April the planted seedlings are 60 to 90 cm high and by the end of the second year 2 m high. The intercropping incidentally eliminates weeding cost. Graziers keep their flock off *Casuarina* plantations if they are intercropped.

Age of Felling

2.16 Generally, farmers plan cultivation for harvest at the end of the fifth or sixth year. More than 63 per cent realise their objective. But 20 per cent have commitments to pay off loans, meet important expenses, discharge certain social obligations or raise money to buy land or a house. The rest are influenced by the brokers and other considerations.

Bullock-cart Transport System

2.17 Like *Prosopis*, *Casuarina* is transported by bullock-carts. Some carts carrying only *Casuarina*, some carts take stone, soil, bricks, farmyard manure etc. It is estimated that a maximum of eight trips (20 to 25 km) are made per month totalling about 75 trips a year. The rate per trip of Rs. 150-200 and the gross earnings will be Rs. 11,250 to Rs. 15,000. After setting apart feeding charges of bullocks the net yearly earning will vary from Rs. 3,750 to 7,000. The regular use of carts has kept cart making and upkeep giving employment to village artisans like carpenter, blacksmith, etc.

2.18 Charcoal Making.—Since the entire biomass fetches good price due to proximity to Madras and other consuming centres very little is left for charcoal making. Generally, the felling contractors engages small groups of persons, mostly from Scheduled Castes, to make charcoal out of unsalable root material at a fixed rate per bag of charcoal. It is a poorly organised activity compared to that of *Prosopis* charcoal. The rural poor, again Schedules Castes, mostly buy the

Bullock-cart as a public carrier for the transport of *Casuarina* produce

Rural poor preparing charcoal out of left over and pruned materials from coupe contrtactors.

leftover and pruned material from fellings and convert them into bundles and take them for sale by their carts to nearby towns. *Casuarina* husbandry provides for self employment of socially handicaped.

Casuarina "Cones"

2.19 The dry "Cones" of *Casuarina* are good domestic fuel of the poor and they are collected free of cost. Of late a trade has developed in South Arcot and Trichy districts. It takes four to five days to collect a bag (20 – 25 kg) of cones and sold to buyers for Rs. 15 to 20 per bag. The merchants sell them to bakeries, gram frying shops at Rs. 25 per bag.

ANATOMY OF CASUARINA TRADE

3.01 Estimation of Growth

Trading starts the day the grower offers his plantation for sale. He estimates the growth empirically, consulting other growers and brokers. Of the growers interviewed 43 per cent said some scientific method of estimation should be made known. They are up-to-date on market prices through various brokers, *Casuarina* transport drivers, etc. But they know little about market economy, namely the forces that detrmine the prices from time to time.

3.02 **Market Categories.** – The buyer, hereinafter called seller, maintains close contact with his leading brokers, two or three in Madras city (the biggest consuming and transit centre) and other places and accordingly plans, times and organizes cutting operations. The common market categories are as follows : –

Category	Dimensions	Utilisation	Prevailing prices in Rs. per tonne in Madras city as on Nov. 1991
1. Firewood billet	2 ft. long (60 cm)	Fuel (domestic, hotels, etc.)	700
2. Roots	Roots with stem 1.25 – 1.5 ft (0.375 – 0.45 m)	Fuel (kilns, hotels, etc.)	500
3. Centering pole	10 – 15 ft. long & 2.5 – 3 in. dia. (3 – 4.5 m) (63 – 75 mm)	Construction	700
4. Scaffolding	any length 2 – 3 in. (50 – 75 mm)	Construction	650 – 700
5. Plantain prop	8 – 10 ft. long &1.5 – 2.5 in. dia. (2.4 – 3 m) (38 –63 mm)	Agriculture	700
6. Lops and Tops	Bundles of 4 tail pieces 4 – 10 ft. long (1.2 – 3 m)	Fuel for boilers, modern rice mills, brick kilns	500
7. Milars (Finer branches)	5 kg. bundles	Common fuel for low income group and wage earners	200 – 400

The categories 1 and 2 are in demand round the year. Regarding items 3 and 4 the demand is periodic and it is on the increase due to great spurt in building activities in Madras. Item 5 is seasonal. Items 3,4 and 5 are taken up only on specific orders. But the main staple of *Casuarina* trade is billets. If no orders for items 3,4 and 5 are forthcoming the billets are sent to the city. The conversion is a feverish race against time because any delay will add to the interest burden. Item 6 and 7 are available as and when conversion takes place.

3.03 The trees are cut into billets 60 cm long and made into stacks 10' x 5' x 2' (300 x 150 x 60 cm) called "Koduthai" which is a convenient measurement for payment of wages. Each koduthai of 100-110 cft is reckoned as 1.5 tonnes. The logs dry up fast and so will have to be sold fast. Items 3, 4, and 5 are usually transported the night after felling so there is not much drying up. The milars are taken by small contractors who own bullock-carts. They make small bundles of five kg and sometimes do home delivery too, as in Pondicherry. The leftover milars are used sometimes as green leaf manure in paddy fields.

Casuarina **Broking**

3.04 In the city *Casuarina* market is controlled by 20- 25 brokers (mostly Nadar group) who also look after timber trade. The broker's trade is highly institutionalized. The buyers place their orders with the brokers. As soon a lorry arrives at a commission *mandy* a few billets are taken as samples. Then a fixed quntity of 75 kg/tonne is deducted towards loss of moisture. This works out to 900 kg per lorry load of 12 tonnes. At the ruling price agreed upon the total amount is worked out for the consignment, and an eight per cent commission on the sale amount from the total is charged and the seller's account settled.

3.05 In this trade the broker is the happiest of all. He gets nearly Rs. 100 per tonne from the seller on account of commission and the eluding dryage from the seller and a similar commission from the buyer totalling Rs. 156 per tonne if the consignment changes hands at the price and quantity billed for the seller. Next comes the grower who often gets his price if the broker does not find him in pressing circumstance. Last comes the buyer turned seller who walks a tight rope. He has to be extremely careful about what he does between the grower and the broker. Very often his business ends up in keeping his lorries on the road and he finds very little beyond.

ANNEXURE – I

MENSURATION TABLES

CASUARINA EQUISETIFOLIA

SOIL TYPE	BLACK SOIL
IRRIGATION / RAIN FED	RAIN FED
AGE OF TREES	48 MONTHS
CORRELATION COEFFICIENT	0.9025
QUALITY CLASS	ALL DATA
THE REGRESSION LINE IS : HEIGHT = 3.984 + 0.438 G B H	

HEIGHT ESTIMATION TABLE

G B H	HEIGHT	G B H	HEIGHT	G B H	HEIGHT
9.00	7.93	10.00	8.36	11.00	8.80
12.00	9.24	13.00	9.68	14.00	10.12
15.00	10.55	16.00	10.99	17.00	11.43
18.00	11.87	19.00	12.31	20.00	12.74
21.00	13.18	22.00	13.62	23.00	14.06
24.00	14.50	25.00	14.93	26.00	15.37
27.00	15.81	28.00	16.25	29.00	16.69
30.00	17.12	31.00	17.56	32.00	18.00
33.00	18.44	34.00	18.88	35.00	19.31
36.00	19.75	37.00	20.19	38.00	20.63
39.00	21.07	40.00	21.50	41.00	21.94
42.00	22.38	43.00	22.82	44.00	23.26
45.00	23.69	46.00	24.13	47.00	24.57
48.00	25.01	49.00	25.45	50.00	25.88
51.00	26.32	52.00	26.76	53.00	27.20
54.00	27.64	55.00	28.07	56.00	28.51
57.00	28.95	58.00	29.39	59.00	29.83
60.00	30.26				

CASUARINA EQUISETIFOLIA

SOIL TYPE	BLACK SOIL
IRRIGATION / RAIN FED	RAIN FED
AGE OF TREES	48 MONTHS
CORRELATION COEFFICIENT	0.9869
QUALITY CLASS	ALL DATA
THE REGRESSION LINE IS :	MERCHANTABLE VOLUME = 0.0026800 + 4.66477E−06 G* G* HT

VOLUME TABLE

GIRTH	HEIGHT							
	6.00	7.00	8.00	9.00	10.00	11.00	12.00	13.00
9.00	0.0049	0.0053	0.0057	0.0061	0.0065	0.0068	0.0072	0.0076
10.00	0.0055	0.0059	0.0064	0.0069	0.0073	0.0078	0.0083	0.0087
11.00	0.0061	0.0066	0.0072	0.0078	0.0083	0.0089	0.0095	0.0100
12.00	0.0067	0.0074	0.0081	0.0087	0.0094	0.0101	0.0107	0.0114
13.00	0.0074	0.0082	0.0090	0.0098	0.0106	0.0114	0.0121	0.0129
14.00	0.0082	0.0091	0.0100	0.0109	0.0118	0.0127	0.0137	0.0146
15.00	0.0090	0.0100	0.0111	0.0121	0.0132	0.0142	0.0153	0.0163
16.00	0.0098	0.0110	0.0122	0.0134	0.0146	0.0158	0.0170	0.0182
17.00	0.0108	0.0121	0.0135	0.0148	0.0162	0.0175	0.0189	0.0202
18.00	0.0117	0.0133	0.0148	0.0163	0.0178	0.0193	0.0208	0.0223
19.00	0.0128	0.0145	0.0162	0.0178	0.0195	0.0212	0.0229	0.0246
20.00	0.0139	0.0157	0.0176	0.0195	0.0213	0.0232	0.0251	0.0269
21.00	0.0150	0.0171	0.0191	0.0212	0.0233	0.0253	0.0274	0.0294
22.00	0.0162	0.0185	0.0207	0.0230	0.0253	0.0275	0.0298	0.0320
23.00	0.0175	0.0200	0.0224	0.0249	0.0274	0.0298	0.0323	0.0348
24.00	0.0188	0.0215	0.0242	0.0269	0.0295	0.0322	0.0349	0.0376
25.00	0.0202	0.0231	0.0260	0.0289	0.0318	0.0348	0.0377	0.0406
26.00	0.0216	0.0248	0.0279	0.0311	0.0342	0.0374	0.0405	0.0437
27.00	0.0231	0.0265	0.0299	0.0333	0.0367	0.0401	0.0435	0.0469
28.00	0.0246	0.0283	0.0319	0.0356	0.0393	0.0429	0.0466	0.0502
29.00	0.0262	0.0301	0.0341	0.0380	0.0419	0.0458	0.0498	0.0537
30.00	0.0279	0.0321	0.0363	0.0405	0.0447	0.0489	0.0531	0.0573
31.00	0.0296	0.0341	0.0385	0.0430	0.0475	0.0520	0.0565	0.0610
32.00	0.0313	0.0361	0.0409	0.0457	0.0504	0.0552	0.0600	0.0648
33.00	0.0332	0.0382	0.0433	0.0484	0.0535	0.0586	0.0636	0.0687
34.00	0.0350	0.0404	0.0458	0.0512	0.0566	0.0620	0.0674	0.0728
35.00	0.0370	0.0427	0.0484	0.0541	0.0598	0.0655	0.0713	0.0770
36.00	0.0390	0.0450	0.0510	0.0571	0.0631	0.0692	0.0752	0.0813
37.00	0.0410	0.0474	0.0538	0.0602	0.0665	0.0729	0.0793	0.0857
38.00	0.0431	0.0498	0.0566	0.0633	0.0700	0.0768	0.0835	0.0902
39.00	0.0453	0.0523	0.0594	0.0665	0.0736	0.0807	0.0878	0.0949
40.00	0.0475	0.0549	0.0624	0.0699	0.0773	0.0848	0.0922	0.0997
41.00	0.0497	0.0576	0.0654	0.0733	0.0811	0.0889	0.0968	0.1046
42.00	0.0521	0.0603	0.0685	0.0767	0.0850	0.0932	0.1014	0.1097
43.00	0.0544	0.0631	0.0717	0.0803	0.0889	0.0976	0.1062	0.1148
44.00	0.0569	0.0659	0.0749	0.0840	0.0930	0.1020	0.1111	0.1201
45.00	0.0594	0.0688	0.0782	0.0877	0.0971	0.1066	0.1160	0.1255
46.00	0.0619	0.0718	0.0816	0.0915	0.1014	0.1113	0.1211	0.1310
47.00	0.0645	0.0748	0.0851	0.0954	0.1057	0.1160	0.1263	0.1366
48.00	0.0672	0.0779	0.0887	0.0994	0.1102	0.1209	0.1317	0.1424
49.00	0.0699	0.0811	0.0923	0.1035	0.1147	0.1259	0.1371	0.1483
50.00	0.0727	0.0843	0.0960	0.1076	0.1193	0.1310	0.1426	0.1543

VOLUME TABLE *(contd.)*

GIRTH	HEIGHT							
	14.00	15.00	16.00	17.00	18.00	19.00	20.00	21.00
9.00	0.0080	0.0083	0.0087	0.0091	0.0095	0.0099	0.0102	0.0106
10.00	0.0092	0.0097	0.0101	0.0106	0.0111	0.0115	0.0120	0.0125
11.00	0.0106	0.0111	0.0117	0.0123	0.0128	0.0134	0.0140	0.0145
12.00	0.0121	0.0128	0.0134	0.0141	0.0148	0.0154	0.0161	0.0168
13.00	0.0137	0.0145	0.0153	0.0161	0.0169	0.0177	0.0184	0.0192
14.00	0.0155	0.0164	0.0173	0.0182	0.0191	0.0201	0.0210	0.0219
15.00	0.0174	0.0184	0.0195	0.0205	0.0216	0.0226	0.0237	0.0247
16.00	0.0194	0.0206	0.0218	0.0230	0.0242	0.0254	0.0266	0.0278
17.00	0.0216	0.0229	0.0242	0.0256	0.0269	0.0283	0.0296	0.0310
18.00	0.0238	0.0254	0.0269	0.0284	0.0299	0.0314	0.0329	0.0344
19.00	0.0263	0.0279	0.0296	0.0313	0.0330	0.0347	0.0364	0.0380
20.00	0.0288	0.0307	0.0325	0.0344	0.0363	0.0381	0.0400	0.0419
21.00	0.0315	0.0335	0.0356	0.0377	0.0397	0.0418	0.0438	0.0459
22.00	0.0343	0.0365	0.0388	0.0411	0.0433	0.0456	0.0478	0.0501
23.00	0.0372	0.0397	0.0422	0.0446	0.0471	0.0496	0.0520	0.0545
24.00	0.0403	0.0430	0.0457	0.0484	0.0510	0.0537	0.0564	0.0591
25.00	0.0435	0.0464	0.0493	0.0522	0.0552	0.0581	0.0610	0.0639
26.00	0.0468	0.0500	0.0531	0.0563	0.0594	0.0626	0.0657	0.0689
27.00	0.0503	0.0537	0.0571	0.0605	0.0639	0.0673	0.0707	0.0741
28.00	0.0539	0.0575	0.0612	0.0649	0.0685	0.0722	0.0758	0.0795
29.00	0.0576	0.0615	0.0654	0.0694	0.0733	0.0772	0.0811	0.0851
30.00	0.0615	0.0657	0.0699	0.0741	0.0782	0.0824	0.0866	0.0908
31.00	0.0654	0.0699	0.0744	0.0789	0.0834	0.0879	0.0923	0.0968
32.00	0.0696	0.0743	0.0791	0.0839	0.0887	0.0934	0.0982	0.1030
33.00	0.0738	0.0789	0.0840	0.0890	0.0941	0.0992	0.1043	0.1094
34.00	0.0782	0.0836	0.0890	0.0944	0.0997	0.1051	0.1105	0.1159
35.00	0.0827	0.0884	0.0941	0.0998	0.1055	0.1113	0.1170	0.1227
36.00	0.0873	0.0934	0.0994	0.1055	0.1115	0.1175	0.1236	0.1296
37.00	0.0921	0.0985	0.1049	0.1112	0.1176	0.1240	0.1304	0.1368
38.00	0.0970	0.1037	0.1105	0.1172	0.1239	0.1307	0.1374	0.1441
39.00	0.1020	0.1091	0.1162	0.1233	0.1304	0.1375	0.1446	0.1517
40.00	0.1072	0.1146	0.1221	0.1296	0.1370	0.1445	0.1520	0.1594
41.00	0.1125	0.1203	0.1281	0.1360	0.1438	0.1517	0.1595	0.1674
42.00	0.1179	0.1261	0.1343	0.1426	0.1508	0.1590	0.1673	0.1755
43.00	0.1234	0.1321	0.1407	0.1493	0.1579	0.1666	0.1752	0.1838
44.00	0.1291	0.1381	0.1472	0.1562	0.1652	0.1743	0.1833	0.1923
45.00	0.1349	0.1444	0.1538	0.1633	0.1727	0.1822	0.1916	0.2010
46.00	0.1409	0.1507	0.1606	0.1705	0.1804	0.1902	0.2001	0.2100
47.00	0.1469	0.1572	0.1676	0.1779	0.1882	0.1985	0.2088	0.2191
48.00	0.1531	0.1639	0.1746	0.1854	0.1961	0.2069	0.2176	0.2284
49.00	0.1595	0.1707	0.1819	0.1931	0.2043	0.2155	0.2267	0.2379
50.00	0.1659	0.1776	0.1893	0.2009	0.2126	0.2243	0.2359	0.2476

SOIL TYPE	BLACK SOIL
IRRIGATION / RAIN FED	RAIN FED
AGE OF TREES	48 MONTHS
CORRELATION COEFFICIENT	0.9379
THE REGRESSION LINE IS : TOTAL WEIGHT = −41.629 + 3.589 G B H	

TOTAL WEIGHT TABLE

G B H	WEIGHT	G B H	WEIGHT	G B H	WEIGHT
12.00	1.44	13.00	5.03	14.00	8.62
15.00	12.21	16.00	15.79	17.00	19.38
18.00	22.97	19.00	26.56	20.00	30.15
21.00	33.74	22.00	37.33	23.00	40.92
24.00	44.51	25.00	48.10	26.00	51.68
27.00	55.27	28.00	58.86	29.00	62.45
30.00	66.04	31.00	69.63	32.00	73.22
33.00	76.81	34.00	80.40	35.00	83.99
36.00	87.58	37.00	91.16	38.00	94.75
39.00	98.34	40.00	101.93	41.00	105.52
42.00	109.11	43.00	112.70	44.00	116.29
45.00	119.88	46.00	123.47	47.00	127.05
48.00	130.64	49.00	134.23	50.00	137.82
51.00	141.41	52.00	145.00	53.00	148.59
54.00	152.18	55.00	155.77	56.00	159.36
57.00	162.94	58.00	166.53	59.00	170.12
60.00	173.71				

SOIL TYPE	BLACK SOIL
IRRIGATION / RAIN FED	RAIN FED
AGE OF TREES	48 MONTHS
CORRELATION COEFFICIENT	0.9370
THE REGRESSION LINE IS : MERCHANTABLE WEIGHT = −36.301 + 3.076 G B H	

MERCHANTABLE WEIGHT TABLE

G B H	WEIGHT	G B H	WEIGHT	G B H	WEIGHT
12.00	0.61	13.00	3.69	14.00	6.76
15.00	9.84	16.00	12.92	17.00	15.99
18.00	19.07	19.00	22.14	20.00	25.22
21.00	28.30	22.00	31.37	23.00	34.45
24.00	37.52	25.00	40.60	26.00	43.68
27.00	46.75	28.00	49.83	29.00	52.90
30.00	55.98	31.00	59.06	32.00	62.13
33.00	65.21	34.00	68.28	35.00	71.36
36.00	74.44	37.00	77.51	38.00	80.59
39.00	83.66	40.00	86.74	41.00	89.82
42.00	92.89	43.00	95.97	44.00	99.04
45.00	102.12	46.00	105.20	47.00	108.27
48.00	111.35	49.00	114.42	50.00	117.50
51.00	120.58	52.00	123.65	53.00	126.73
54.00	129.80	55.00	132.88	56.00	135.96
57.00	139.03	58.00	142.11	59.00	145.18
60.00	148.26				

SOIL TYPE	RED SOIL
IRRIGATION / RAIN FED	IRRIGATED
AGE OF TREES	72 MONTHS
CORRELATION COEFFICIENT	0.8770
QUALITY CLASS	ALL DATA
THE REGRESSION LINE IS :	HEIGHT = 4.556 + 0.422 G B H

HEIGHT ESTIMATION TABLE

G B H	HEIGHT	G B H	HEIGHT	G B H	HEIGHT
9.00	8.35	10.00	8.78	11.00	9.20
12.00	9.62	13.00	10.04	14.00	10.46
15.00	10.89	16.00	11.31	17.00	11.73
18.00	12.15	19.00	12.57	20.00	13.00
21.00	13.42	22.00	13.84	23.00	14.26
24.00	14.68	25.00	15.11	26.00	15.53
27.00	15.95	28.00	16.37	29.00	16.79
30.00	17.22	31.00	17.64	32.00	18.06
33.00	18.48	34.00	18.90	35.00	19.33
36.00	19.75	37.00	20.17	38.00	20.59
39.00	21.01	40.00	21.44	41.00	21.86
42.00	22.28	43.00	22.70	44.00	23.12
45.00	23.55	46.00	23.97	47.00	24.39
48.00	24.81	49.00	25.23	50.00	25.66
51.00	26.08	52.00	26.50	53.00	26.92
54.00	27.34	55.00	27.77	56.00	28.19
57.00	28.61	58.00	29.03	59.00	29.45
60.00	29.88				

CASUARINA EQUISETIFOLIA

SOIL TYPE	RED SOIL
IRRIGATION / RAIN FED	IRRIGATED
AGE OF TREES	72 MONTHS
CORRELATION COEFFICIENT	0.9761
QUALITY CLASS	ALL DATA
THE REGRESSION LINE IS : MERCHANTABLE VOLUME = 0.0037400 + 4.83700E−06 G*G*HT	

VOLUME TABLE

GIRTH	HEIGHT							
	6.00	7.00	8.00	9.00	10.00	11.00	12.00	13.00
9.00	0.0061	0.0065	0.0069	0.0073	0.0077	0.0080	0.0084	0.0088
10.00	0.0066	0.0071	0.0076	0.0081	0.0086	0.0091	0.0095	0.0100
11.00	0.0073	0.0078	0.0084	0.0090	0.0096	0.0102	0.0108	0.0113
12.00	0.0079	0.0086	0.0093	0.0100	0.0107	0.0114	0.0121	0.0128
13.00	0.0086	0.0095	0.0103	0.0111	0.0119	0.0127	0.0135	0.0144
14.00	0.0094	0.0104	0.0113	0.0123	0.0132	0.0142	0.0151	0.0161
15.00	0.0103	0.0114	0.0124	0.0135	0.0146	0.0157	0.0168	0.0179
16.00	0.0112	0.0124	0.0136	0.0149	0.0161	0.0174	0.0186	0.0198
17.00	0.0121	0.0135	0.0149	0.0163	0.0177	0.0191	0.0205	0.0219
18.00	0.0131	0.0147	0.0163	0.0178	0.0194	0.0210	0.0225	0.0241
19.00	0.0142	0.0160	0.0177	0.0195	0.0212	0.0229	0.0247	0.0264
20.00	0.0153	0.0173	0.0192	0.0212	0.0231	0.0250	0.0270	0.0289
21.00	0.0165	0.0187	0.0208	0.0229	0.0251	0.0272	0.0293	0.0315
22.00	0.0178	0.0201	0.0225	0.0248	0.0272	0.0295	0.0318	0.0342
23.00	0.0191	0.0217	0.0242	0.0268	0.0293	0.0319	0.0344	0.0370
24.00	0.0205	0.0232	0.0260	0.0288	0.0316	0.0344	0.0372	0.0400
25.00	0.0219	0.0249	0.0279	0.0309	0.0340	0.0370	0.0400	0.0430
26.00	0.0234	0.0266	0.0299	0.0332	0.0364	0.0397	0.0430	0.0462
27.00	0.0249	0.0284	0.0319	0.0355	0.0390	0.0425	0.0461	0.0496
28.00	0.0265	0.0303	0.0341	0.0379	0.0417	0.0455	0.0492	0.0530
29.00	0.0281	0.0322	0.0363	0.0404	0.0444	0.0485	0.0526	0.0566
30.00	0.0299	0.0342	0.0386	0.0429	0.0473	0.0516	0.0560	0.0603
31.00	0.0316	0.0363	0.0409	0.0456	0.0502	0.0549	0.0595	0.0642
32.00	0.0335	0.0384	0.0434	0.0483	0.0533	0.0582	0.0632	0.0681
33.00	0.0353	0.0406	0.0459	0.0511	0.0564	0.0617	0.0669	0.0722
34.00	0.0373	0.0429	0.0485	0.0541	0.0597	0.0652	0.0708	0.0764
35.00	0.0393	0.0452	0.0511	0.0571	0.0630	0.0689	0.0748	0.0808
36.00	0.0414	0.0476	0.0539	0.0602	0.0664	0.0727	0.0790	0.0852
37.00	0.0435	0.0501	0.0567	0.0633	0.0700	0.0766	0.0832	0.0898
38.00	0.0456	0.0526	0.0596	0.0666	0.0736	0.0806	0.0876	0.0945
39.00	0.0479	0.0552	0.0626	0.0700	0.0773	0.0847	0.0920	0.0994
40.00	0.0502	0.0579	0.0657	0.0734	0.0811	0.0889	0.0966	0.1043
41.00	0.0525	0.0607	0.0688	0.0769	0.0850	0.0932	0.1013	0.1094
42.00	0.0549	0.0635	0.0720	0.0805	0.0891	0.0976	0.1061	0.1147
43.00	0.0574	0.0663	0.0753	0.0842	0.0932	0.1021	0.1111	0.1200
44.00	0.0599	0.0693	0.0787	0.0880	0.0974	0.1067	0.1161	0.1255
45.00	0.0625	0.0723	0.0821	0.0919	0.1017	0.1115	0.1213	0.1311
46.00	0.0652	0.0754	0.0856	0.0959	0.1061	0.1163	0.1266	0.1368
47.00	0.0678	0.0785	0.0892	0.0999	0.1106	0.1213	0.1320	0.1426
48.00	0.0706	0.0818	0.0929	0.1040	0.1152	0.1263	0.1375	0.1486
49.00	0.0734	0.0850	0.0966	0.1083	0.1199	0.1315	0.1431	0.1547
50.00	0.0763	0.0884	0.1005	0.1126	0.1247	0.1368	0.1488	0.1609

VOLUME TABLE (*contd.*)

GIRTH	HEIGHT							
	14.00	15.00	16.00	17.00	18.00	19.00	20.00	21.00
9.00	0.0092	0.0096	0.0100	0.0104	0.0108	0.0112	0.0116	0.0120
10.00	0.0105	0.0110	0.0115	0.0120	0.0124	0.0129	0.0134	0.0139
11.00	0.0119	0.0125	0.0131	0.0137	0.0143	0.0149	0.0154	0.0160
12.00	0.0135	0.0142	0.0149	0.0156	0.0163	0.0170	0.0177	0.0184
13.00	0.0152	0.0160	0.0168	0.0176	0.0185	0.0193	0.0201	0.0209
14.00	0.0170	0.0180	0.0189	0.0199	0.0208	0.0218	0.0227	0.0236
15.00	0.0190	0.0201	0.0212	0.0222	0.0233	0.0244	0.0255	0.0266
16.00	0.0211	0.0223	0.0236	0.0248	0.0260	0.0273	0.0285	0.0297
17.00	0.0233	0.0247	0.0261	0.0275	0.0289	0.0303	0.0317	0.0331
18.00	0.0257	0.0272	0.0288	0.0304	0.0319	0.0335	0.0351	0.0367
19.00	0.0282	0.0299	0.0317	0.0334	0.0352	0.0369	0.0387	0.0404
20.00	0.0308	0.0328	0.0347	0.0366	0.0386	0.0405	0.0424	0.0444
21.00	0.0336	0.0357	0.0379	0.0400	0.0421	0.0443	0.0464	0.0485
22.00	0.0365	0.0389	0.0412	0.0435	0.0459	0.0482	0.0506	0.0529
23.00	0.0396	0.0421	0.0447	0.0472	0.0498	0.0524	0.0549	0.0575
24.00	0.0427	0.0455	0.0483	0.0511	0.0539	0.0567	0.0595	0.0622
25.00	0.0461	0.0491	0.0521	0.0551	0.0582	0.0612	0.0642	0.0672
26.00	0.0495	0.0528	0.0561	0.0593	0.0626	0.0659	0.0691	0.0724
27.00	0.0531	0.0566	0.0602	0.0637	0.0672	0.0707	0.0743	0.0778
28.00	0.0568	0.0606	0.0644	0.0682	0.0720	0.0758	0.0796	0.0834
29.00	0.0607	0.0648	0.0688	0.0729	0.0770	0.0810	0.0851	0.0892
30.00	0.0647	0.0690	0.0734	0.0777	0.0821	0.0865	0.0908	0.0952
31.00	0.0688	0.0735	0.0781	0.0828	0.0874	0.0921	0.0967	0.1014
32.00	0.0731	0.0780	0.0830	0.0879	0.0929	0.0978	0.1028	0.1078
33.00	0.0775	0.0828	0.0880	0.0933	0.0986	0.1038	0.1091	0.1144
34.00	0.0820	0.0876	0.0932	0.0988	0.1044	0.1100	0.1156	0.1212
35.00	0.0867	0.0926	0.0985	0.1045	0.1104	0.1163	0.1222	0.1282
36.00	0.0915	0.0978	0.1040	0.1103	0.1166	0.1228	0.1291	0.1354
37.00	0.0964	0.1031	0.1097	0.1163	0.1229	0.1296	0.1362	0.1428
38.00	0.1015	0.1085	0.1155	0.1225	0.1295	0.1364	0.1434	0.1504
39.00	0.1067	0.1141	0.1215	0.1288	0.1362	0.1435	0.1509	0.1582
40.00	0.1121	0.1198	0.1276	0.1353	0.1430	0.1508	0.1585	0.1663
41.00	0.1176	0.1257	0.1338	0.1420	0.1501	0.1582	0.1664	0.1745
42.00	0.1232	0.1317	0.1403	0.1488	0.1573	0.1659	0.1744	0.1829
43.00	0.1290	0.1379	0.1468	0.1558	0.1647	0.1737	0.1826	0.1916
44.00	0.1348	0.1442	0.1536	0.1629	0.1723	0.1817	0.1910	0.2004
45.00	0.1409	0.1507	0.1605	0.1703	0.1800	0.1898	0.1996	0.2094
46.00	0.1470	0.1573	0.1675	0.1777	0.1880	0.1982	0.2084	0.2187
47.00	0.1533	0.1640	0.1747	0.1854	0.1961	0.2068	0.2174	0.2281
48.00	0.1598	0.1709	0.1821	0.1932	0.2043	0.2155	0.2266	0.2378
49.00	0.1663	0.1779	0.1896	0.2012	0.2128	0.2244	0.2360	0.2476
50.00	0.1730	0.1851	0.1972	0.2093	0.2214	0.2335	0.2456	0.2577

CASUARINA EQUISETIFOLIA

SOIL TYPE	RED SOIL
IRRIGATION / RAIN FED	IRRIGATED
AGE OF TREES	72 MONTHS
CORRELATION COEFFICIENT	0.9028
THE REGRESSION LINE IS : TOTAL WEIGHT = −42.283 + 3.853 G B H	

TOTAL WEIGHT TABLE

G B H	WEIGHT	G B H	WEIGHT	G B H	WEIGHT
12.00	3.95	13.00	7.81	14.00	11.66
15.00	15.51	16.00	19.36	17.00	23.22
18.00	27.07	19.00	30.92	20.00	34.78
21.00	38.63	22.00	42.48	23.00	46.34
24.00	50.19	25.00	54.04	26.00	57.89
27.00	61.75	28.00	65.60	29.00	69.45
30.00	73.31	31.00	77.16	32.00	81.01
33.00	84.87	34.00	88.72	35.00	92.57
36.00	96.42	37.00	100.28	38.00	104.13
39.00	107.98	40.00	111.84	41.00	115.69
42.00	119.54	43.00	123.40	44.00	127.25
45.00	131.10	46.00	134.95	47.00	138.81
48.00	142.66	49.00	146.51	50.00	150.37
51.00	154.22	52.00	158.07	53.00	161.93
54.00	165.78	55.00	169.63	56.00	173.48
57.00	177.34	58.00	181.19	59.00	185.04
60.00	188.90				

SOIL TYPE	RED SOIL
IRRIGATION / RAIN FED	IRRIGATED
AGE OF TREES	72 MONTHS
CORRELATION COEFFICIENT	0.9059
THE REGRESSION LINE IS : MERCHANTABLE WEIGHT = −37.213 + 3.343 G B H	

MERCHANTABLE WEIGHT TABLE

G B H	WEIGHT	G B H	WEIGHT	G B H	WEIGHT
12.00	2.90	13.00	6.25	14.00	9.59
15.00	12.93	16.00	16.27	17.00	19.62
18.00	22.96	19.00	26.30	20.00	29.65
21.00	32.99	22.00	36.33	23.00	39.68
24.00	43.02	25.00	46.36	26.00	49.71
27.00	53.05	28.00	56.39	29.00	59.73
30.00	63.08	31.00	66.42	32.00	69.76
33.00	73.11	34.00	76.45	35.00	79.79
36.00	83.13	37.00	86.48	38.00	89.82
39.00	93.16	40.00	96.51	41.00	99.85
42.00	103.19	43.00	106.54	44.00	109.88
45.00	113.22	46.00	116.57	47.00	119.91
48.00	123.25	49.00	126.59	50.00	129.94
51.00	133.28	52.00	136.62	53.00	139.97
54.00	143.31	55.00	146.65	56.00	150.00
57.00	153.34	58.00	156.68	59.00	160.02
60.00	163.37				

ANNEXURE – II

COMPILATION OF TREE HUSBANDRY PRACTICES IN TAMIL NADU

Questionnaire

Prosopis juliflora

I The Tract

a) Topography, type of soil, depth of soil, pan, if any :
b) Total rainfall, season, distribution, number of rainy days :
c) Land capability and use :
d) Occupation of people :
e) Agricultural cropping & changes in cropping patterns during the past decade, if any :

II Presence of *Prosopis*

a) Are there blocks of lands / largeholdings under *Prosopis juliflora* and if so are the Government lands, private or any other category ? :
b) Extent and location (name of villages or proximity to roads and railway) :
c) If non-governmental property, name of the owner/holder/custodian :
d) How has *Prosopis* come to stay ?
   i) Is it due to response to certain Land Acts ? :
   ii) Are land & climatic resources too inadquate to support profitable agriculture ? :
   iii) Are agricultural inputs too costly to be invested in the land ? :
   iv) Is organisation of labour in time becoming too difficult ? :
   v) Is it due to absentee landlord management ? :

III The growth

a) Age of growth/regrowth :
b) Density of growth (No. of bushes / ha by sampling:
c) Average number of stem per stool and average height :

IV *Prosopis* **husbandry**

a) What are the prevailing practices to promote growth ? :
b) Is *Prosopis* raised on a regular plantation scale and if so, details :
c) What are the prevailing empirical cutting cycles ? reasons for such practices :

V Extraction (Organisation of work)

a) Is the extraction work done by lumpsum contract / labour contract / wage labour ? :
b) Requirement of manpower (man and woman-days) per tonne of materials at site :
c) Cost of cutting and extraction per tonne of materials at site :
d) Yield of saleable material per hectare :

VI Charcoal making (Organisation of work)

a) Size of stacks and weight of material stacked :
b) Man and woman-days and time required for making stacks of common size and cost
c) Details about the process :
d) Yield (by weight) of charcoal in per cent of wood used :
e) Cost of charcoal making per quintal :
f) Price of charcoal per bag (... kg/quintal)
g) Uses of charcoal :
h) Consuming centres within the state and outside :
i) Is charcoal making a pooled effort of individuals or organised industry ? Details :

VII Socio-economic impact

a) How much wage labour do *Prosopis* husbandry and charcoal making provide in the village tract ? :
b) What kind of skills are imparted to the local people ? :
c) How much has *Prosopis* husbandry con tributed to the socio-economic wellbeing of the rural poor ? :
d) Has this contributed to any industrial activity at cottage / small scale level in the tract ? If so, details. :

ANNEXURE – II *(contd.)*

COMPILATION OF TREE HUSBANDRY PRACTICES IN TAMIL NADU

Questionnaire

Casuarina equisetifolia

I. General

a) Name of landholder :
b) Extent of holding in acres :
c) Type of soil - Red, Black cotton, Coastal sand :
d) Irrigated or rainfed :
e) Crops cultivated prior to Casuarina planting :
f) Present crops in the nearby holdings :

II Reasons for switching to *Casuarina* planting

a) Due to rising cost of agricultural inputs :
b) Due to labour difficulties (high wages, difficuties in securing labour in time etc.) :
c) Due to lumpsum return after a few years :
d) Due to absentee landlord management. :

III Source of information regarding seedling supply, cultivation and market

a) Empirical knowledge by word of mouth :
b) Government :
c) Consultancy :

IV Seedling supply

a) From where obtained :
b) Size (height in cm) and number :
c) Season and month :
d) Price Rs. ...../1000 :

V Land Preparation

a) Season and month :
b) Ploughing by country plough or tractor in terms of hours or days per acre :
c) Cost per acre and labour (man-days) :
d) Any input of farmyard manure / fertilizer, quantity, cost :

VI Planting

a) Season and month of Planting :
b) Spacing between rows and on the rows :
c) In singles or clusters, number per acre :
d) Cost per acre and labour (man and woman-days) :

VII Labour deployment

a) On a piece-rate basis :
b) On daily wage basis :
c) Reasons :

VIII Upkeep of plantation

a) Is intercropping practised ? If so the duration and species cropped and return per acre in the year of planting and subsequent years :
b) Number of weedings in the year of planting and subsequent years. :
c) Replacement of casualities in the year of planting and second year :
d) Cost per acre and labour (man-days and woman-days) :

IX Pruning

a) Age of first and second prunings :
b) Is pruning done on piece rate or by wage labour and total labour and cost per acre ? :
c) Disposal of pruned materials and return per acre :

X How decision for sale of growth is made

a) Is it due to buyer's or broker's pressure ? :
b) Is it to meet urgent, important commitment of the grower ? :
c) Is it ripe for realising the maximum return ? :

XI Estimate of saleable growth

a) How are estimates made ? :
b) Does the grower know how to estimate ? :
c) Does he go by the estimate of the buyer or the broker ? :
d) Does he feel the need for unbiased scientific estimate ? :

XII *Casuarina* market information

a) Does the grower know about *Casuarina* utilization, market trends and market prices ? :

XIII Disposal of growth

a) How are trees felled, converted and categorized for the market ? :
b) Is the labour specially skilled ? :
c) Implements used ? :
d) Labour (man and woman-days) input per tonne or number of pieces and cost :

XIV Any other point :

ANNEXURE – III

TOURS, VISITS AND DISCUSSIONS

08 – 06 – 91 Took professors of Statistics Department of Madras Christian College (MCC) Tambaram, on a visit to *Casuarina* plantations in Chengalpattu–MGR and South Arcot districts. (Mamandur, Tindivanam, Marakanam, Vanangupattu, Mudaliarkuppam etc) and back to Madras.

28 – 06 – 91 Took professors and students of Statistics Department of Madras Christian College, Tambaram on an exposure visit and introduction to field work in *Casuarina* husbandry in Chengalpattu–MGR and South Arcot districts.

01 –07 – 91 Left for Madurai and halt.

02 – 07 – 91 March to Tirunelveli by road *enroute* to Srivilliputhur, Sivakasi, Sattur, Kovilpatti, Sankarankoil, Devarkulam, Manur and halt.

03 – 07 – 91 Tiruneveli to Kamudi by road *enroute* Sivalperi, Maniyachi, Vallinayagapuram, Ottappidaram, Vilathikulam, Nagalapuram, Vedanatham, Aruppukkottai, Parthipanur, returned to Madurai and halt.

04 – 07 – 91 Left for Madras by road.

05 – 07 – 91 Arrival at Madras.

20 – 07 – 91 Left Madras for Tindivanam by road. Mensuration work in Pangolathur private *Casuarina* plantations work by staff and students of Madras Christian College and halt at Marakkanam.

21 – 07 – 91 Visited *Casuarina* planations on Tindivanam–Pondicherry road and Pondicherry–Villupuram road and to Tindivanam and halt.

22 – 07 – 91 Left for Annamalainagar and halt. *Enroute* visit to *Casuarina* plantations.

23 – 07 – 91 Return to Tindivanam. *Enroute* visited *Casuarina* plantations on Chidambaram –Cuddalore and Cuddalore–Virudhachalam roads and then to Madras.

26 – 07 – 91 Left for Paramakudi by rail.

27 – 07 – 91 Arrival at Paramakudi. Visit to Parathipanur, Perungkaranai tank *Babul / Prosopis* plantations, Sundanenthal, Melakodamular.

28 – 07 – 91 Proceeded to Ramanathapuram by road and halt. Visit to Devipatinam, Nandagaeri, Vani nursery, Departmental-*Prosopis* plantation (10 ha).

29 – 07 – 91 March to Tirunelveli by road via Tuticorin. Visit *enroute Prosopis* growth and halt.

30 – 07 – 91 Visit to *Prosopis* areas in Sivalperi, Vaipar, Vembar, Vilathikulam, Ettayapuram, Eppothumvendran, Kayathar and halt at Tirunelveli.

31 – 07 – 91 Visit to *Prosopis* areas along river courses of Tamparabarani via Srivaikundam, Alwar Tirunagari, Thenthiruperai, Korkai, Punnakkayal, Attur and halt at Tirunelveli.

01 – 08 – 91 Visit to *Prosopis* areas along upper reaches of Tamparabarani, Cheranmadevi and left to Madras.

02 – 08 – 91 Arrival at Madras.

16 – 08 – 91 Left for Chidambaram by train.

17 – 08 – 91	Arrival at Chidambaram. Visit to *Casuarina* plantations along Chidambaram-Cuddalore road and private padugai plantations and halt.
18 – 08 – 91	Padugai private *Casuarina* plantations on Kattumannarkudi road near Meensurutty, private nurseries of kisans of Aranthangi and halt.
19 – 08 – 91	Visit to private *Casuarina* plantations of Melmanakkudi, Kaduvetti and Ponnankuppam and halt.
20 – 08 – 91	Discussion with subordinates for information and data. Left Chidambaram for Madras by train.
17 – 09 – 91	Left Madras for Tirunelveli.
18 – 09 – 91	Arrival at Tirunelvei. Visit to *Prosopis* areas in Sivalperi and upper Tamparabarani.
19 – 09 – 91	Visit to *Prosopis* areas in Uppakuruchi, Thalayuthu, Sivalperi, Villakku, Maniyachi, Kadambur, Eppothumvendran, Vilathikulam and return via Ettayapuram and Kovilpatti and halt.
20 – 09 – 91	Trek to Paramakudi enroute *Prosopis* areas in Sattur, Irrukkankudi, Masarpatti, Melakkaranthai, Pandalkudi, Aruppukkottai, Narikudi, Melamadavur, Parthipanur.
21 – 09 – 91	Visit to Patel charcoal unit, Seeniappa bricks and tiles unit, Manamaduari Co-operative Pottery unit and halt.
22 – 09 – 91	Discussion with Principal Investigator in the forenoon and trek to Karaikudi by road via Manamadurai, Sivaganga, Tiruppattur and halt.
23 – 09 – 91	Visit to *Prosopis* areas enroute Sevarakkottai, Veerai along Kallal river. Poyyalur Elumappatti: Left Kariakudi and arrived at Muthupet by train.
24 – 09 – 91	Visit to *Prosopis* areas of coastal Thanjavur district. Left for Madras by train.
25 – 09 – 91	Arrival at Madras.
12 – 10 – 91	Left Chidambaram by train. Arrival at Chidambaram and halt.
13 – 10 – 91	Visit to *Casuarina* private plantations at Sillankuppam, Portnovo, Pudupettai, Samiar pettai, Alappakkam.
14 – 10 – 91	Visit to Padugaithittu *Casuarina* Plantations. Left for Madras by train.
15 – 10 – 91	Arrival at Madras.
24 – 10 – 91	Discussion with the Principal Field Investigator (*Casuarina*) at Madras.
26 – 10 – 91	Left Madras for Maduari by train.
27 – 10 – 91	Arrival at Madurai and halt.
28 – 10 – 91 29 – 10 – 91	Discussion with the Principal Field Investigator (Prosopis).
29 – 10 – 91	Left Madurai for Madras by train.
30 – 10 – 91	Arrival at Madras.
07 – 11 – 91	Proceeded to Marakkanam by road. Discussion with *Casuarina* growers/merchants. Returned to Madras.

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